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AN ANALYSIS OF GRAIN STORAGE IN THREE INTERIOR SAHEL COUNTRIES

by

Annette M. Pinckney

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CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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CHAPTER I

INTRODUCTION AND SUMMARY

In each Sahel country several groups and organizations are responsible for grain storage: farmers, traders, cooperative organizations, regional development organizations (ORDs in Upper Volta), specialized development agencies (les Opérations) and state marketing authorities. The distribution of existing physical capacity and volume of stocks among these groups depends on such factors as: (1) the marketed share of domestic grain output; (2) the structure of marketing institutions (relative importance of the public to the private sector in grain trade) and (3) the degree of development of the rural cooperative. By far the most important group, measured by volume and duration of storage, are farmers. At the farm level, impetus for cereals storage derives from the necessity of providing, for a local population, carryover stocks until the next harvest or for a longer term in the event of a shortfall in production. In this context, stocks are mainly held to meet the consumption demand of farm/village units between harvests, with some margin for seed. Given underlying cereal production conditions as well as consumption patterns, the marketed share of locally-produced grains is, in general, small relative to total production. Moreover, only a modest amount of grains is traded in bulk. This is especially true of the coarse cereals, millet and sorghum, which tend to be traded in small quantities in an atomistic market.

The concern with grain storage in the Sahel countries has grown out of interest in foodgrain marketing strategies and price policies. If, in coming years, there is a trend toward increasing monetization of the agricultural sector through increasing purchases of grain by producing and non-producing populations, the resource costs of maintaining and managing substantial stocks of perishable commodities on both a short and long-term basis must be taken into account in defining a marketing strategy. In the long run, improved technology in domestic foodgrain production and increased productivity (yields) should lead to surpluses over the immediate needs of local producers. Where this is accompanied by growing urban populations, with increased specialization within the rural sector and expanded rural markets, there will be an increase in the effective internal demand for marketed cereals. Exports, of course, should increase also. The primary function of grain inventories in a widening and deepening market for foodgrains is to enhance the efficiency of grain markets; stockholding is a mechanism to smooth out temporary excesses in supply and demand in time and space, and hence serves to modulate price swings.

As marketing institutions develop, some shift will occur in the distribution of grain stocks between on-farm populations and other stockholding groups. Such shifts will raise the question as to what extent storage costs can be absorbed by the private sector, and more generally, the respective use of public and private resources for the acquisition and maintenance of grain stocks. The resource costs of grain storage include: a) investment in warehouse infrastructure; b) investment in grain stocks; c) preservation and conservation costs, such as supplies, equipment maintenance, and personnel; d) management-related inputs.

But this is looking ahead. At the present stage of development of marketing institutions, stores of grains controlled at the farm level account for 75-80 percent of total stocks.[1] These stocks constitute the foodgrain reserves of subsistence producers, and a critical issue of storage policy is whether there are substantial returns from public investments in small-scale, on-farm storage infrastructure and stock conservation. Investments of both types are intended to reduce real storage costs in the form of losses. These issues are taken up in Chapter III of this report.

Nevertheless, 20-25 percent of total grain production does move in trade. Cereal movements occur between surplus production and deficit areas--urban conglomerations and rural areas producing insufficient grains. This means that there are rudimentary grain storage systems in place which facilitate cereal flows from farms to off-farm polulations. Chapter II examines foodgrain storage arrangements in the three interior countries of Mali, Niger, and Upper Volta (in turn), with the objective of presenting, in a systematic fashion, current systems of storage associated with marketing activities in these countries.

While it is analytically correct to regard grain storage as one component of the total grain marketing system, the Sahel governments have tended to view grain storage systems as a self-contained strategy, to be used to achieve the equalization in the supply of, and demand for, foodgrains in both time and space. Just as official marketing systems have been developed with a view toward implementing price and income policies,[1] storage is regarded as a tool for ameliorating price and income fluctuations over the course of one or several years. Grain storage as an instrument of public policy has become fashionable among Sahel governments as a means of coping with the instability of agricultural production and the volume of marketed output. Rainfall dependence, compiled with the widespread employment of low-level production techniques, are conducive to sharp variations in agricultural production, income and prices. The drought experience of 1971-74 brought sharp declines in producer welfare as crop failures resulted in the disappearance of community food reserves and as aggregate payments to crop producers fell. While relief supplies modified income losses to some extent, the money economy regressed as subsistence producers channelled land and labor into food production. In order to maintain the real incomes of urban consumers at a constant level as world cereal prices rose, the Sahel governments allocated enormous budgetary resources for the purpose of subsidizing retail prices of cereals.

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[1] Rice is excepted from this general statement. The limited quantity of rice produced in Sahel countries generally takes place under conditions such that the bulk of production is marketed.

With this experience in mind, governments view grain storage systems as a buffer against the future recurrence of these events. Stocks are to be accumulated against a long-term decline in production. There are other problems as well which would be attacked through grain storage systems. For example, even under conditions where total production remains relatively stable for several years, but major harvests occur once a year, grain stocks are drawn down to relatively low levels before harvest (farm and off-farm supplies). The problem of low stock levels prior to harvest (the so-called soudure) is expected to be reduced through the build-up of inventories for release at critical periods during the year. Further, existing impediments to marketing such as widely dispersed markets and poor transport (which gives rise to large intra-country price differentials) would be reduced by holding of grain inventories and the interregional redistribution of grains.

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[1] Public grain agencies were established to intervene in grain markets for the avowed purpose of stabilizing consumer prices and to support producer incomes. This was to be accomplished through purchase of grain at harvest in order to raise the price, and through sale later in the year to promote a decline in market prices.

These views of the role of grain storage explain policies and programs currently under consideration in the three countries. For example, there is a tendency to create specialized storage organizations, such as the Sous Comité in Upper Volta, which are concerned solely with the redistribution of grain output. Likewise, normal pipeline grain stocks handled by the public grain agencies are officially designated as "les stocks régulateurs" to emphasize their intended role as price regulators. Mali, Niger and Upper Volta have adopted in recent years the so-called grain reserve concept, where governments plan investments in long-term stock reserves to compensate for cyclical swings in production. Strategic grain stock programs would protect a country against the potential disruption to production caused by chronic rainfall insufficiency and would reduce the need for large-scale, short-term grain imports. National grain reserves pose complex issues of economic efficiency and welfare as well as questions of distributional tradeoffs between various affected groups. Economic theory suggests that a country can achieve a higher level of welfare by exporting grain production surpluses. However, for the interior countries there may be some relative advantage in financing and maintaining some level of national cereal reserves, since transport costs add significantly to costs of imported grains.

This report is divided into two main parts. In Chapter II, the current grain storage systems of Mali, Niger and Upper Volta are presented in detail. That chapter provides information on in-transit storage facilities for use during the grain collection season, public sector storage capacity, and levels of estimated stockholdings.

Chapter III takes up current issues in the grain storage area. The first section looks at on-farm storage and the prospects for investments in low-technology improvements in this type of storage. The next section takes up community/village level storage, which has come to be viewed in some countries as a substitute for on-farm storage. Finally, some issues of long-term grain reserve programs are examined.

CHAPTER II

GRAIN MARKETING AND STORAGE INSTITUTIONS

INTRODUCTION

This section describes storage arrangements within the framework of the characteristics of the cereals economies and marketing organizations of the interior states. It is concerned with stocks held in the normal pipeline for grain milling and distribution. The general characteristics of the cereals of the three interior states are typical of the Sahel. Millet and sorghum are the main staples, supplemented by lesser production of rice and maize (production). The farming sector is overwhelmingly subsistence-oriented, with some cash cropping (groundnuts, cotton, sheanuts, cowpeas and sesame) and some sales of grains.

Two types of marketing organizations for food crops coexist in each of the three countries: a state structure and a private structure. In each country there is a public agency with responsibility for grain trade,[1] and laws exist which prohibit private trade in grains except as specified by the authority. In reality these legal monopolies are not implemented, so extensive and active private marketing systems exist. The private sector handles at least half of the total volume of the trade in grains. However, although private marketing structures are large measured in terms of the total volume of grain traded, they are small and non-specialized. In private trade, grains tend to move in units of relatively small magnitudes. Grains are stored, therefore, in units of similar magnitudes. In general, private grain stocks are scattered and decentralized. This is underlined in the 1977 CILSS report titled Marketing, Price Policy and Storage of Foodgrains in the Sahel, which observes:

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[1] Office des Produits Alimentaires du Mali (OPAM); Office des Produits Viviers du Niger (OPVN); Office National des Céréales, Upper Volta (OFNACER).

> " Very limited amounts of grains are stored by traders. It is rare in most of the region to find private traders with a storage capacity of as much as 50 tons. Most storage, like most trading activity, is mixed; i.e., grains and other commodities, frequently sugar, will be stored in the same place; generally a room or two in a rather rudimentary building." (Vol.I, p. 73).

Thus, when speaking of foodgrain storage systems and storage infrastructure in the context of marketing, the focus is on the public sector and the activities of the various agencies which make up this sector. In each of the three countries there is, to be sure, considerable discrepancy between reality and intent in the official marketing of foodgrains; grain agencies have never played a major role in the market in any country. Nevertheless, storage systems are described within the framework of official marketing objectives for the reason that governments tend to assess grain storage capacity and needs with reference to these objectives.

This chapter outlines for each country the public agencies responsible for grain storage and provides data on stock levels and storage capacity of the public agencies. This provides a picture of the movement of grains through the marketing system and serves to indicate the extent to which grain agencies are able to meet storage requirements and maintain stocks in accordance with their official mandates. The data presented in this section are descriptive. Estimates of stock levels and information on storage capacity have been gathered from various sources. Although such "official" information provides a general picture of the current situation, there is a lack of precision in the data both with respect to stockholding and storage facilities. Storage capacity is an illusive concept. Total storage capacity for a given country cannot be defined with rigor since the quality and condition of all structures is not known. Further, some facilities may be temporary or provisional. There is a lack of uniformity in construction and design, and even in the basic purpose of structures defined as grain storage facilities.[1] In all three countries there are older public sector storage facilities in need of renovation or replacement by structures built to more appropriate specifications for storing grains.

Two problems which plague national storage programs are 1) the dearth of management-related inputs and 2) high physical losses of grain stocks. There has been no attempt to quantify losses. Accounting data made available by public grain agencies include in "losses" reductions in grain stocks due to theft, illegal contracts, and the like; there is no measurement of physical disappearance of stocks due to lack of quality control. Technical experts observing the handling and management of grain stocks report the presence of rodent and insect damage, the general absence of appropriate loss control measures, and have concluded that overall losses are high relative to the quantity of stocks handled by national grain agencies.

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[1] Donors providing food assistance to the interior countries do maintain staffs which periodically survey and assess the conditions of facilities in which donor grains are stored. This ongoing surveillance should be reflected to some extent in official capacity estimates.

CHAPTER III

MALI

Among the interior countries, Mali is distinguished by the intervention of the state in the economy. There is an effort to impose a state monopoly on the purchase and sale of foodgrains to local consumers through the state marketing agency, OPAM. OPAM buys stocks through the intermediary of the *groupment rural*, an association of village-level producer cooperatives. A second source of domestic grain stocks are the Millet and Rice Opérations. The latter are development organizations which concentrate on a particular crop. The Opérations are responsible for supplying producers with technical services and inputs. They are responsible within their production zones for the primary collection of the crop for which extension services are provides. Although OPAM is authorized to commercialize the major grains during designated marketing seasons, and is responsible for the distribution of grain stocks to urbanized areas and deficit production regions, the structure of the official marketing system has tended to place the grain agency in a secondary position with respect to the formulation of marketing policy, and has denied the agency financing autonomy. Moreover, from the standpoint of the marketing process and marketing strategy, there have been certain limitations on the agency's operating procedures and its role in decision-making. These limitations have implications for the national grain storage and distribution systems.

The Collecte Primaire and Redistribution Systems

The policy-marking process behing OPAM collection operations has evolved as the responsibility of a group of agencies collectively designated as the Administration within the Government of Mali, and a Cereals Committee. The functions of the Administration and Committee have been to forecast production levels and set marketing quotas by *arrondissement*, *cercle* and *région*; decide upon the details of the marketing season (dates, allocation of funds for bagging and transport); establish a program for the interregional distribution of grains; and finally, to determine producer prices, price schedules *(barêmes)* and retail prices to consumers.

As this system has developed, while OPAM was granted the virtual monopoly of grain marketing during the annual campaign, in actual practice the primary collection of cereal production has fallen to the producer cooperatives and their federation; the grain agency is not placed in direct contact with its suppliers or suppliers' associations. Under the cooperative-collection system, until grain stocks have reached the level of the *cercle*, the grain agency is not responsible for warehousing; in-transit storage is handled by the villages themselves and the federation of producer cooperatives.

In general what occurs is that individual producer (*chef de famille*) will bag the grain which he has contracted to sell, and will deliver the sacks to a village-level collection point.[1] In some instances there are rudimentary storage facilities at the village level; "banco structures" or bags are stored in open air. Banco structures are semi-permanent, requiring rebuilding after one or more seasons or rainfall. The efficient movement of grains (realization of minimum losses) from production points to chef lieux depends upon the timely movement of grains out of open-air storage into warehouses. This requires, in turn, a relatively well-developed transport infrastructure and a sufficient number of vehicles. Transport is particularly significant in view of the concentration of OPAM storage facilities in the capitals of the cercles; this practice increases the distance grains must be hauled.

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[1] Note that the system requires a degree of accuracy in forecasting on the part of the Malian farmer. If he underestimates the amount which he intends to sell, funds for grains and/or sacks may be fully distributed by the time his grains are harvested. However, if he overestimates, he can draw down his grain stocks from a previous season. The latter does not appear to be an uncommon practice. (AID *Project Evaluation Report, Opération Mil Mopti*, 1977).

The cooperative federation provides transport for bagged grain from village depots to the level of the arrondissements. Transport costs between these points are estimated on the basis of a weighted average of fifty kilomenters, and under current price schedules 52 MF per metric ton are allocated to village-arrondissement transport costs. In the barême, or price schedule, for millet and sorghum shown in Table III-1, this is included under the frais de collecte in Item 2. Bagging and administration (weighing, inspection) represent the remainder of the collection costs shown.

At the arrondissement level, storage facilities are found in banco, "en dur" (concrete) and "semi-dur" (banco reinforced with concrete). There is, on the average, a reported maximum of 500 metric tons of storage capacity per arrondissement, which are under the control of the cooperative federation. OPAM provides the transport from the arrondissement to the cercle, using either its own vehicle fleets or depending upon private sector transport facilities. The cost of transport between these points is

Table III-1

EFFECTIVE PRICE SCHEDULE (BARÊME) FOR MILLET AND SORGHUM, IN MALIAN FRANCS, 1977

(based on one metric ton)

1.	Prix au Producteur	36,000
2.	Frais de Collecte	3,386
3.	Prix de session (chef lieux arrondissement)	39,386
4.	Frais de ramassage	3,900
5.	Prix de revient (cercle)	43,286
6.	Taxe OPAM	47,500
7.	Frais de Transport (pondere)	48,000
8.	Frais de bancaire (5-15%)	52,700
9.	Soutien ORSP	1,800
10.	Marge de detail des cooperatives	3,000
11.	Prix à la consommation	56,500

Source: Malian Authorities

estimated on the basis of a weighted average of 75 kilometers, and is included in the barême under cost Item 4. OPAM allocates 3,000 MF per metric ton for transport to the cercle.

Once grain stocks have been assembled at the level of the cercle, the program for redistribution between zones is carried out. Given the estimated level of consumption for each cercle relative to the volume of cereal output, a certain volume of stocks may remain at the cercle. The excess marketed stocks are transported to deficit cercles within the same region or will be moved to other deficit regions. Such movements are based on GOM estimates of consumption requirements relative to production forecasts.[1] Any surpluses remaining after these distributions are placed in the Bamako area. If a global deficit is anticipated, import requirements are estimated and a schedule of grain imports is planned, including grains requested under international assistance programs.

National Grain Storage Capacity

As indicated in the discussion above, the temporary storage of grains in transit does not come under the auspicies of the grain agency. OPAM's storage services begin at the level of the cercle, where it functions to take on stocks and to organize the dispatching of supply between zones. It maintains regional grain warehouses in the primary porduction zones and in deficit areas. Most of this storage is to provide warehousing for what

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[1] The sophistication of the analysis underlying these steps should not be overestimated. Production and sales results of previous seasons from the basis of such estimates, linked undoubtedly to some intuitive adjustments for the effects of current rainfall patterns.

TABLE III-2

Published Estimates of Public Sector Grain Storage Capacity

A. IBRD Estimate of OPAM Grain Storage Capacity, by Region

(in metric tons)

Region	
Segou	45,000
Mopti	30,000
Sakasso	7,000
Bamako	30,000
Gao	20,000
Kayes	6,000
TOTAL	138,000

Source: IBRD, Mali Report, January 1978.

B. CILSS Estimate of OPAM Grain Storage Capacity, by Region, 1976.

	Warehouses		Silos		
Region	number	capacity	number	capacity	Total Capacity
Kayes	7	7,300	6	3,000	10,000
Bamako	27	27,900	22	12,100	40,000
Sikasso	4	8,800	-	-	8,800
Segou	5	27,600	-	-	27,600
Mopti	29	27,600	16	8,800	36,400
Gao	15	18,070	6	3,300	21,370
Total	90	130,722	50	27,500	131,222

Source: CILSS Report, Marketing, Price Policy and Storage of Food Grain Storage in the Sahel, 1977.

TABLE III-3

REGIONAL DISTRIBUTION OF OPAM STORAGE CAPACITY, 1978
(in metric tons)

		Warehouses	Silos[a]	Total
1.	District of Bamako	12,460	7,150	19,610
2.	Kayes	2,800	2,200	5,000
3.	Koulikoro	4,200	-	4,200
4.	Sikasso	6,160	-	6,160
5.	Segou	30,130	5,500	35,630
6.	Mopti	15,960	11,000	26,960
7.	Tombouctou	5,495	-	5,495
8.	Gao	6,965	6,600	13,565
	TOTAL:	84,170	32,450	116,620

[a] 550 metric ton units.

Source: OPAM, March 1978.

are called consumption stocks, i.e., stocks drawn down in the course of normal demand over the year.

Recent information published on OPAM grain storage capacity indicates levels in excess of 130,000 metric tons distributed among the six regions. Two such recent estimates are shown in Table III-2. For example, the IBRD, in its latest Report on Mali, shows total capacity at 138,000 metric tons. The 1977 CILSS marketing study indicated a total capacity of 131,000 metric tons. The accuracy of these estimates is questionable. Some recent data on OPAM storage facilities are shown in Table III-3. According to these data the capacity in warehouse structures is 84,170 metric tons, with an additional capacity in silos of 32,450 metric tons. This brings the total estimated capacity to 166,620 metric tons. The revised figures may not reflect a reduction in the total number of units included in the count, but instead may reflect the estimated maximum amount of space available for a given number of sacks. The number of sacks of grain that can be stored at a given location is not measured by the total square meters of a given structure; room must be allowed for ventilation in stacking.

Approximately two-thirds of conventional storage capacity is located in the productive regions of Segou, Mopti and Sekasso. About one-third is distributed among the foodgrain importing regions of Bamako, Gao and Kayes. Overall capacity has been more equally distributed between productive and importing regions through the build-up of silo units. About one-half of new silos have been located in the importing regions.

Table III-4 shows the regional breakdown of OPAM storage infrastructure. In practically all instances, the bulk of storage facilities are

TABLE III-4

REGIONAL STORAGE CAPACITY OF OPAM: ESTIMATED UTILIZABLE CAPACITY, JANUARY 1978

Location	Stores-Warehouses		Silos	
	Number	Tonnage	Number (550mt each)	Tonnage
Bamako		12,460	13	7,150
Kayes				
Kayes		2,800	-	-
Bafoulabe		-	-	-
Kenieba		-	-	-
Kita		-	-	-
Koulikoro				
Banamba		-	-	-
Dioila		-	-	-
Kangaba		-	-	-
Kolokani		-	-	-
Koulikoro		3,500	-	-
Kati		-	-	-
Nara		700	-	-
Sikasso				
Sikasso		2,660	-	-
Bougouni		2,800	-	-
Kadiolo		-	-	-
Kolondieba		-	-	-
Koutiala		700	-	-
Yanfolila		-	-	-
Segou				
Segou		21,380	-	-
Macina		1,400	-	-
Niono		-	-	-
San		7,350	10	5,500
Tominian		-	-	-
Bla		-	-	-
Baroueli		-	-	-

Table III-4 continued

Location	Stores-Warehouses		Silos	
	Number	Tonnage	Number (550 mt each)	Tonnage
Mopti				
Mopti		10,360	20	11,000
Bandiagara		--		
Bankass		700		
Djenne		700		
Douentza		--		
Koro		700		
Tenenkou		3,500		
Youwarou		--		
Tombouctou				
Tombouctou		455	--	--
Dire		2,800		
Goundam		840		
G. Rharous		1,400		
Niafunke		--		
Gao				
Gao		4,410	12	6,600
Bourem		1,750		
Ansongo		--		
Menaka		350		
Kidal		455		

SOURCE: OPAM, March 1978.

situated in capitals. While there may be economies to be derived from the centralization of storage facilities (lower inspection and treatment costs) the absence of the dispersion of warehousing intra-regionnally imposes additional transport burdens on some foodgrain suppliers. In principle, when Opérations are suppliers, OPAM is to receive grains at the _chef lieux_ of the _arrondissements_. However, since the grain agency does not maintain sufficient administrative infrastructure or physical facilities at these locations, as a general rule it receives the merchandise in the capitals of the _cercles_. The cereals Opérations, which are responsible for the transport from the collection points to the _chef lieux_, are experiencing increasingly higher costs due to transport. The Opérations, for example Opération Mil Mopti, receive 2,786 MF per metric ton for all activities involved in the collection process. Since the Operations bear the costs of losses involved in collection operations, they bring what ever warehouse structures are available into use for grain storage during the period of collection in order to minimize the risks of loss on grains in transit. Such structures, however, are intended primarily for housing production inputs. Opérations do not maintain physical facilities specifically for housing grain stocks.

Stock Levels

OPAM, through its official monopoly, picks up approximately 8 percent of millet and corn production and perhaps 30 percent of rice output. Trade in the "parallel market" by private traders equals or exceeds OPAM in the care of coarse grains, in most areas of the country. In Table III-5 an estimate of the evolution of the official commercialization of

TABLE III-5

COMMERCIALIZATION OF MILLET AND CORN, 1972-1977
(in metric tons)

Year	5th Region Imopti	All Regions	Direct OMM[a]
1972	6,120	28,700	-
1973	1,030	10.910	-
1974	3,810	9,860	-
1975	11,360	49,740	8,705
1976	10,960	42,890	8,440
1977	12,740	40,900	5,400

Source: AID, Project Evaluation Report, Opération Mil Mopti., 1977.

[1] Opération Mil Mopti. in the 1976/77 campaign, it was decided that in the Bankaes and Djenné Cercles, existing cooperatives would take over grain collection, delivering directly to OPAM. Thus the data for 1977 excluded Bankaes and Djenné.

the coarse grains is given. According to this source, in the last three years, with near normal rainfall, the marketed share of coarse grains has averaged about 45,000 metric tons per annum.[1] Official marketing of rice output has run about 50-60,000 metric tons over the period if a factor of 30 percent is applied to production estimates. Given these magnitudes of the net additions to grain stocks, the overall volume of stocks controlled by OPAM implies fairly high-use rates of existing storage infrastructure.

In addition to stocks acquired through domestic grain purchases, imports are a second source of grain stocks. Mali maintains a substantial grain trade with neighboring countries. Because of significant intercountry price differentials (low official producer prices at home relative to consumer prices abroad), there is a large volume of unofficial trade in grains which is unrecorded in published data. It is not unrealistic to suppose that a substantial percentage of the grains which are acquired in the parallel market are not stored for domestic sale, but are moved out of the country. On the basis of official trade statistics provided by the Central Bank and shown in Table III-6, over the past two years Mali has been a net exporter of grains. Imports, at least until the recent rainfall deficiency, had declined substantially from immediate post-drought levels.

In the two years of good rainfall after the drought, the GOM had built up almost 18,000 metric tons of grains under its Reserve Stock Program. Table III-7 shows the reserve stock position as it existed in the fall of 1976. Since that time, these stocks have been drawn down, and as of the first quarter of 1978 the GOM had no balance of reserve stocks.

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[1] The figures conform to those shown in OPAM, Rapport d'Activite, 1974-1976.

TABLE III-6

VALUE AND QUANTITY OF OFFICIAL EXTERNAL TRADE IN CEREALS 1975-1977

		Imports		Exports	
Year	Commodity	Quantity	Value	Quantity[1]	Value
1975	Rice	Purchases: 15,000	3.0	-	none
		Food Aid: 8,000			
1976		Purchases: None	-	18,000	2.4
		Food Aid: None			
1977		n.a.	n.a.	n.a.	2.4 (estimated)

Source: Banque Centrale de Mali, March 1978.

[1] OPAM, Rapport d'Activité, 1976.

TABLE III-7

SITUATION OF RESERVE STOCKS, AUGUST 31, 1976
(in metric tons)

Location (Region)	Type of Structure	Tonnage
Mopti	n.a.	11,500
Bamako	conventional warehouse	497
Sogoniko	conventional warehouse	2,857
Sogoniko	metalic warehouse	484
n.a.	in silos	2,308
Total		17,646

Source: OPAM, Rapport D'Activité, Sept. 1975-1976.

CHAPTER IV

NIGER

On the basis of expressed policy objectives, the GOM has made a serious effort to intervene in the market for foodgrains through price policies, cereal distribution and storage networks. The public sector cereals marketing and storage systems are represented by the grain agency OPVN and the Union Nigerienne de Credit et de Cooperation (UNCC).[1] OPVN is the executing agent for a cereals marketing policy which is formulated in the Ministry of Economic Affairs and guided by the National Committee for Cereals. The UNCC is responsible for the annual collecte primaire from primary producers in rural markets in areas in which producer cooperatives have been established, buying from both cooperative and non-cooperative producers who trade in the market. It is estimated that OPVN picks up about 6 percent of domestic production of coarse grains, millet and sorghum. Some 15 percent of grain production is handled by private traders. Roughly 80 percent of millet and sorghum production remains at the farm level. A current judgement is that stocks equivalent to perhaps 70-75 kilograms per inhabitant are stored on-farm.

Collection and Redistribution Systems

The primary role of the grain agency has been to take on stocks from productive regions and redistribute grain throughout the country. As Table IV-1 shows, OPVN acquires grain stocks in surplus production areas

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[1] The UNCC is a national agency primarily in charge of the formation of rural cooperatives and the provision of technical assistance and inputs to cooperatives. Grain marketing is a subsidiary activity.

TABLE IV-1

OPVN MILLET AND SORGHUM PURCHASES, BY REGION AND PRIMARY AGENT, 1977
(in metric tons)

	Millet				Sorghum			
Region	UNCC	Traders	Direct Purchase	Total	UNCC	Traders	Direct Purchase	Total
Niamey	532	905	-	1,437	5	-	-	5
Dosso	-	120	11	131	-	-	-	-
Touahoua	112	519	-	631	17	-	-	17
Maradi	1,200	99	-	1,299	125	-	-	125
Zinder	919	-	-	919	27	-	-	27
Diffa	-	-	-	-	232	126	411	769
Totals:								
All Grains	5,363	-	-	-	-	-	-	-
UNCC Share	2,762	-	-	-	407	-	-	407
Traders	-	1,643	-	-	-	126	-	126
Direct Purchase	-	-	11	-	-	-	411	411

Source: Office of the Entente Fund, Niamey.

by three means: UNCC purchases, private (licensed) traders, and to some extent, through direct purchases by the grain agency. The latter are primarily sorghum purchases, and if the figures in Table IV-1 are representative, the direct purchases of sorghum are about equal to UNCC collections. Under the structure of the official marketing system, the UNCC is supposed to serve as the primary contact with the agency's grain suppliers. It finances its primary collection activities through a 6.5 percent loan from the CNCA (Agricultural Credit Bank). During the period of the campaign, on market days the UNCC exercises a monopoly on producer grain sales in rural markets. Agents may rent some type of temporary warehousing near primary marketing locations until stocks are moved to permanent facilities. Most often, however, sacks are stacked in the open air. The movement of foodgrains from these collection points is the responsibility of OPVN,which, in principle, moves the grain within one week of collection. OPVN in-transit costs, from market to warehouses, are shown in the *barême* in Table IV-2 under item four as 1,700 CFA F per metric ton.

In some regions traders supply OPVN with a greater proportion of its stock acquisitions than does the cooperative federation. Traders contract to deliver grains directly to OPVN warehouses so that the agency does not incur a transport cost on trader deliveries. However, the total stock acquisition cost to OPVN on grain supplied by traders is higher than of UNCC. The *barême* in Table IV-2 shows that this arises from the higher commission paid to private traders. The differential amounts to 2,500 CFA F as shown under item two of the schedule.

Following the collection process, OPVN redistributes grain stocks among departments in accordance with estimates of consumption requirements.

TABLE IV-2

PRICE SCHEDULE (BARÊME) FOR MILLET AND SORGHUM, PER KILOGRAM, ESTABLISHED FOR OPVN BY TYPE OF AGENT, 1977 (in CFAF)

	Millet and White Sorghum		Red Sorghum	
	Traders	UNCC	Traders	UNCC
Price paid to producers	30.00	30.00	25.00	25.00
Commission	4.00	1.50	4.00	1.50
Stock preparation, tagging operations, etc.	2.05	2.05	2.05	2.05
Transport (from markets to stores)	--	1.70	--	1.70
OPVN administrative and overhead costs	4.30	4.30	4.30	4.30
Provision for debt	2.00	2.00	2.00	2.00
Treatment of stocks	.10	.10	.10	.10
SUBSTOTAL of OPVN costs:	42.45	41.65	37.45	36.65
ADD:				
Estimated costs of interregional transfers	6.00	6.00	6.00	6.00
Total cost to OPVN	48.45	47.65	43.45	42.65
OPVN sale price	40.00	40.00	30.00	30.00
Estimated loss to OPVN per kilogram	8.45	7.65	13.45	12.65

SOURCE: OPVN, Niamey

The second element in the barême shows an estimated redistribution cost of 6,000 CFA F per metric ton to OPVN on grains transferred between regions. At current levels of official cereal prices, consumers are subsidized by between 8 and 13.50 CFA F per kilogram through the agency's stock and redistribution operations.

Stockholdings

National grain stocks are held at two levels. First, under the arrangements between the UNCC and local cooperatives, 10 percent of the primary collection is turned over to local cooperatives and stored at the local level. As discussed below, the UNCC and cooperatives maintain local grain storage facilities. The second group of stockholdings are those of OPVN which are composed of domestic stock purchases and official imports. The latter include grains purchased from neighboring countries directly by the grain agency as well as cereals coming in under foreign assistance programs. The levels of stocks shown in Table IV-3 probably do not take account of cereals coming in under recent international assistance agreements. In recent years, OPVN has imported substantial amounts of grains under direct purchase contracts from neighboring-country grain producers. These include OPAM in Mali, OFNACER in Upper Volta, and foodgrains from Nigeria.[1] These sources make up the so-called "stocks regulateurs", stocks to be drawn down with the objective of making incremental adjustments to local supply as demand conditions change over the course of the year.

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[1] Imports of millet, sorghum and rice are reported as follows for the year 1976/77: Mali: 5,000 MT; Upper Volta: 5,574; Nigeria: 4,600 MT.

TABLE IV-3

OPVN STOCKS AVAILABLE FOR COMMERCIALIZATION, BY DEPARTMENT, AS OF JANUARY, 1978
(in metric tons)

Department	Millet	Sorghum	Corn	Rice	Wheat	Total
Niamey	1,610	3,310	500	179		5,599
Tahoua	1,022	1,100		47		2,169
Maradi	2,261	1,788	100	59	21	4,208
Zinder	758	428	173	23		1,382
Diffa	226	10		57		293
Agadez	668	617		358		1,643
Dosso	675	1,075		419		2,169
Totals:	7,220	8,328	673	1,142	21	17,384

SOURCE: Office of the Entente Fund, Niamey

In addition to these stocks, OPVN at present is holding stocks for the government under the Emergency Reserve Stock program. Table IV-4 indicates that the agency holds approximately 15,000 metric tons of millet and sorghum. These stocks are located in the three departments of Maradi, Tahoua and Zinder.

Storage Capacity

There are in Niger three general categories of public sector storage facilities: warehouses in arrondissements controlled by the UNCC and its cooperatives; conventional warehouses and stores owned by OPVN; and special silos constructed for long-term grain storage which are under the direction of OPVN.

1. UNCC-Cooperative Storage.-- The UNCC controls its own network of stores and also manages facilities belonging to the cooperatives. In all cases these stores serve multiple uses and are not solely available for grain storage. Space in local warehouses is used for storing of fertilizers, seed, and equipment. Local warehouses are used as well in the commercialization of cash crops and other foodstuffs. It is roughly estimated that these competing uses reduce the area specifically allocatable to grain storage to between one-quarter and one third of total capacity. Both the FED and the IBRD were active in the construction of local storage facilities between 1968 and 1975. As a result of this financing of facilities to augment UNCC and cooperative stores, it is estimated that about 9,000 metric tons of capacity are available which meet minimum conditions for storing grains for other than very short periods.

TABLE IV-4

OPVN: RESERVE STOCK POSITION, JANUARY 1978
(in metric tons)

Department	Millet	Sorghum	Wheat
Dosso	--	--	--
Tahoua	800	--	--
Maradi	8,116[1]	--	--
Zinder	6,574	510	--
Diffa	--	--	--
Agadez	--	--	--
Niamey	--	--	--
Total:	14,770	510	

SOURCE: Office of the Entente Fund, Niamey

[1] A source within OPVN reports reserve stocks located at Maradi as 7,339 metric tons.

2. OPVN Storage.-- Official estimates of OPVN grain storage capacity demonstrate considerable variability. Table IV-5 provides two different estimates of the number of OPVN warehouses and their capacity, broken down by department. The figures under Roman numeral I are based on public documents made available by the Office of the Director at OPVN. The figures in parentheses under Roman numeral II are derived from Table IV-6. This table shows a breakdown of storage facilities by district in the seven departments. These data were drawn from other documents issued within the grain agency and show an overall reduction in estimated capacity.

The variance in the estimates of the number of structures owned by OPVN and corresponding capacity suggests that additions to capacity and the withdrawal of some older facilities are in process. Such shifts make difficult a precise accounting of total capacity at a point in time. Investments are currently being planned, and as the financing of these investments is assured, the capacity represented by planned investments may be included in published totals before actual construction is realized. Another source of discrepancy between the estimates may be due to a revision of construction standards which leads to the elimination of facilities of low quality. It is reported that in the Niamey Department, particularly, there are a number of relatively small storage structures (each having a capacity of 100 metric tons) which are, in fact, unsuitable for storage of grains for any period of time. A more rigorous assessment of the quality and condition of structures, and the gradual subtraction from totals of small banco structures, for example, gives a more realistic picture of storage infrastructure.

TABLE IV-5

OPVN GRAIN STORAGE CAPACITY, 1978
(in metric tons)

Department	Number of Warehouses		Capacity[1]	
	I	II	I	II
Niamey	15	(15)	14,500	(13,500)
Dosso	11	(10)	9,000	(5,000)
Touhoua	11	(13)	13,500	(11,500)
Agadez	4	(3)	4,000	(4,000)
Diffa	9	(7)	7,500	(5,500)
Maradi	13	(14)	11,000	(11,500)
Zinder	16	(18)	13,500	(16,500)
Total:	79	(80)	73,000	(67,500)

SOURCE: Office of the Director, OPVN, Niamey.

[1] Figures in parentheses derived from Table IV-7.

TABLE IV-6

OPVN GRAIN STORAGE AND PLANNED CAPACITY BY LOCATION OF STORAGE STRUCTURES, DECEMBER 1977

(in metric tons)

Location	Number of Structures	Capacity
Department - Niamey		
Niamey	8	9,500
Balleyara	1	500
Say	1	500
Tera	1	500
Tillaberry	1	500
Ouallam	1	1,000
Filingue	2	1,000
Department - Dosso		
Dosso	5	1,000
Kare Mairoua	1	500
Gaya	1	1,000
Degondoutchi	1	1,500
Loga	1	500
Birni-N'Gaoure	1	500
Department - Tahoua		
Tahoua	2	2,500
Bouza	1	500
Illela	1	500
Keita	1	500
Birni N'konni	5	5,000
Tchintabaraden	1	500
Madaoua	2	2,000
Department - Maradi		
Maradi	2	3,000
Guidan-Roumdji	1	500
Aguie	1	500
Dakoro	1	500
Tessaoua	6	4,500
Mayahi	1	500
Gazaoua	1	500
Tchadaoua	1	1,500
Department - Zinder		
Zinder	4	4,000
Goure	1	500
Magaria	2	2,500
Matameye	1	1,000
Mirriah	1	500
Tanout	3	3,000
Bakin-Birgi	4	2,000
Mainasoroa	2	2,000

Table IV-6 continued

Location	Number of Structures	Capacity
Department - Diffa		
Diffa	2	2,000
N'Guimi	5	3,500
Department - Agadez		
Agadez	2	2,500
Arlit	1	1,500

SOURCE: OPVN; R.F.A. Storage Consulting Team.

TABLE IV-7

NIGER: SUMMARY OF STORAGE CAPACITY ESTIMATES
DETAIL OF EXISTING AND PLANNED CAPACITY BY TYPE OF STRUCTURE
AND SOURCE OF FINANCING, 1978
(in metric tons)

	Number	Capacity	
I. Conventional Structures			
A. Realized:	Number	Capacity	
Before 1974:	46	34,500	
Loans & Grant-financed	34	36,000	(includes 7,500 financed under long term storage program)
	80	70,500	
B. Under construction	8	4,000	
II. Silos (Sealed Long-term Structures)			
A. Realized:	Number	Capacity	
Loan & Grant-financed	11	7,500	
B. Financed and under construction	20	10,000	

SOURCE: OPVN, RFA Storage Consultancy Team.

Table IV-7 summarizes the overall situation with respect to OPVN storage infrastructure on the basis of the type of structure and the source of financing. The term "conventional structures" covers various types of storage units, ranging from banco stores to corrugated and concrete structures. The term excludes "silos" which are covered and sealed with butyl substance and used for long-term grain storage. In general, it may be assumed that conventional structures erected since 1974 are more likely to reflect basic minimum standards of construction and quality. In any event, however "official" the estimates, a present total grain storage capacity figure of 70,000 metric tons or more undoubtedly overstates the grain agency's utilizable grain storage infrastructure. This figure becomes more realistic if it is interpreted to include planned investment and construction.

CHAPTER V

UPPER VOLTA

In Upper Volta, several public agencies are directly or peripherally concerned with grain marketing and storage. These include the national grain agency, OFNACER, established in 1970; the Organismes Regionaux du Developpement (ORDs); the Ministry of Rural Development; and the Sous Comité de Lutte contre les Effets de la Secheresse. The Agricultural Services and the Ministry of the Interior also have some responsibility in the grain storage area.

In the eight years since the creation of OFNACER -- which introduced state intervention into grain marketing -- efforts to establish a dual marketing structure and to increase the state's share of the domestic foodgrain market have met with mixed success. At present, Upper Volta's public policy with respect to its official marketing system for domestic grain output and the related question of grain storage are in an unsettled state. In 1974, when OFNACER was granted a monopoly for the sale of cereals to consumers, the ORDs were simultaneously granted a monopoly over the purchase of food crops from producers. For a variety of reasons this official monopoly has not worked out.[1] It is widely known and can-

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[1] The recent CILSS report summarizes the ORD experience in 1974 as follows:

> "The ORDs lacked the staff, the knowledge, and the experience required for foodgrain marketing...Many had no marketing infrastructure at all and, therefore, had to rely on private traders and truckers. All the ORDs were forced to allocate workers, working capital and other resources away from the developmental or productionist role of the organization to the marketing function."

op. cit. Vol. 2 p. 18.

ibid., Vol. II

didly admitted that at present, the role of the ORDs in grain marketing is little more than a legal fiction. Moreover, since the primary function of the ORDs is to promote agricultural and social development, the burdensome and poorly implemented additional responsibility for grain marketing and storage impose high social and economic costs.

Under the (theoretical) operation of the official marketing system, the ORDs are authorized to acquire, through purchase, the marketed share of the nation's grain output. As such, the ORDs at the time of the collecte primaire have been designated as the original repositories of the marketed portion of grain output. Stocks acquired through the purchase of domestic output are, in turn, placed at the disposition of OFNACER for distribution and sale. In addition to domestic stocks, OFNACER receives official imports of grain. A great proportion of imports represent food assistance financed under foreign aid programs. The public marketing authority, however, does not have a unique responsibility for the distribution of grain stocks. The Sous Comité contre les Effects de la Sécheresse oversees the placement of grain stocks in deficit production regions and distressed areas. In the Sahel context, such conditions are chronic and the Sous Comité's role is continuing one, and is not limited to periods of production declines such as the ones which occured between 1971-1974. The broad role of the Sous Comité is to improve the equalization of cereal supply and demand between surplus and deficit regions.

Storage Capacity

The total amount of storage infrastructure owned by each of these organizations can only be roughly estimated. A summary of these estimates is presented in Table V-1. An accurate account of grain storage capacity by sector is hampered by several factors. First, at present, total storage availability at the ORD level is not known, and a census of ORD storage has been authorized. Until this census is completed, ORD grain storage estimates are subject to large error. A second complicating factor is the practice of the exchange of facilities between public agencies and between the public and private sectors. For example, leasing arrangements take place between the Sous Comité and OFNACER. The latter also rents facilities from time to time from private commercants on a short-term basis.

1. ORD Storage.-- An unofficial estimate of the storage capacity owned by the eleven ORDs at the beginning of 1978 is 20,800 metric tons. As indicated above, this figure is only approximate since a census of ORD storage facilities is still in progress. The distribution of the estimated total among ORDs is not available. In any event, the existence of a certain volume of storage capacity at the ORD level does not necessarily mean that space in such structures is allocated totally to foodgrain storage. ORD storage facilities serve mulitple purposes, and are used for such items as insecticides, fertilizers, equipment etc. These competing uses emphasize that the primary responsibility of the ORDs is not grain marketing and storage, but general agricultural development.

2. OFNACER Storage.-- OFNACER estimated total storage capacity, distributed in eight of the ORDs, is shown in Table V-2. The total capacity figure of 25,500 metric tons differs slightly from data prepared in response to a CILSS questionnaire issued in the fall of 1976 which indicated a total of 27,500 metric tons. The 2,000 metric tons difference applies to Ouaga-

TABLE V-1

SUMMARY OF ESTIMATES OF GRAIN STORAGE CAPACITY, 1976 AND (FEBRUARY) 1978

	1976[1]	1978[2]
Public Sector		
1. ORDs	20,800	20,800
2. OFNACER	27,500	25,500
3. Sous Comité	8,200	11,500
4. Potential Emergency Reserve	11,000	11,000 (approx.)
Storage Facilities (Silos)		
Private Sector		
5. Farmers	1,600,000	--
6. Traders	33,000	--

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[1] SOURCE: 1976, C.R.E.D., University of Michigan, CILSS, Club du Sahel, Marketing Price Policy and Storage of Food Grains in the Sahel, Vol. II.

[2] OF NACER.

TABLE V-2

UPPER VOLTA: ESTIMATED PUBLIC SECTOR STORAGE INFRASTRUCTURE

A. OFNACER: Grain Storage Facilities by District, February 1978[1] (capacity in metric tons)

ORD	Department	Capacity	Type of Structure
Centre	Ouagadougou	13,000	concrete; prefabricated
Haut-Bassins	Bobo-Dioulasso	3,000	concrete; prefabricated
Volta Noire	Dedougou	1,500[2]	concrete
Pl. Nord Mossi	Kaya	1,500	concrete
Sahel	Dori	500	concrete
Centre-Est	Koupela	1,500	concrete
Yatenga	Ouahigouya	1,500	concrete
Centre Ouest	Fada N'Gourma	3,000	concrete
	TOTAL:	25,500	

[1] Most of these facilities have been financed by foreign loans and grants. OFNACER's own resources were used to finance facilities in Koupela and Dedougou.

[2] Under construction.

B. Sous Comité: Grain Storage Capacity, February 1978 (in metric tons)

Northern ORDs	11,500
Non-Sahel	3,000[1]
TOTAL:	14,500

[1] Estimated. Facilities are located near Ouagadougou.

SOURCE: OFNACER, Office of the Director.

dougou, where capacity has been reduced from 15,000 to 13,000 metric tons.[1]

More than one half of the grain agency's total infrastructure is located in Ouagadougou. OFNACER maintains facilities with a capacity of 3,000 metric tons each in the departments of Bobo-Dialousso and Fada N'Gourma. Six thousand metric tons are distributed equally between the four Departments of Dedougou, Kaya, Koupela and Ouahigouya. Previously there had been no public sector capacity in the major grain-exporting ORD of Volta Noire, but 1,500 metric tons is reported to be under construction.

At the beginning of 1978, OFNACER was reported to have access to some facilities under lease arrangements with commercants in the private sector. The scale of facilities available for rental on an ad hoc basis consisted of one warehouse of 1,000 metric tons, one warehouse of 500 metric tons, and assorted structures of 20-50 metric ton capacity. Although no data have been gathered on lease-cost financing, an opinion was expressed that OFNACER pays a fairly high price when required to lease private sector facilities.

Table V-3, which shows OFNACER cereal sales by locality for the period April 1, 1975 to March 31, 1976, indicated that 70 percent of the grain agency's stocks were sold in the Department where its facilities are located. However, one observes from the tables that large grain sales occur in areas where warehousing facilities do not appear to exist. For example, in the department of Gorom-Gorom, where OFNACER maintains no

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[1] See paper prepared by A. Pinckney, 1977

TABLE V-3

OFNACER CEREAL SALES, BY LOCALITY, APRIL 1, 1975 TO MARCH 31, 1976
(in metric tons)

	Cereals				
District	Rice	Millet	Sorghum	Corn	
Ouagadougou	3,540	681	1,985	786	6,992
Ziniare					
Kokologo	4				
Dassouri	2				
Bousse	4				
Manga	1				
Sapone	-				
Po	1				
Koudougou	89		8	21	
Manoro	2		3	4	
Yako	21				
Kindi	-				
Sabou	4				
Samba	2				
Tenado	3				
Reo	1				
Bobo	835		525	213	1,573
Banjora	364		2	13	379
Diebougou	2	33			
Boroma	10				
Debougou	132				
Tougan	55				
Nouna	88				
Kassoum	2				
Toma	31				
Safane	9				
Salenzo	6				
Gassan	120				
Ouahigouya	468	11	14		493
Seguenega	9				

Table V-3 continued

District	Rice	Millet	Sorghum	Corn	
Gourcy	11				
Thiou	1				
Koumbri	-				
Djiko	10	44		7	
Arbinda	11	1	8		
Dori	64	35	10	188	
Gorom	9	1,408	488	64	1,969
Markoye	2	259	31		
Kaya	56		2	165	
Boulsa	-				
Mane	-				
Fada N'Gourma	45	6	8	6	
Tembende	-	155	235	4	394
Bogande	9				
Kantchari	13	3			
Koupela	76		1		
Tenkodogo	70				
Zorgho	45				
Boutenga	59				
TOTAL:[1]	6,400	2,635	3,319	1,471	13,825

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[1] Excludes 2,855 metric tons of grains provided under foreign aid programs, mainly sorghum.

SOURCE: Office of the Entente Fund, Niamey.

storage infrastructure, approximately 2,000 metric tons of foodgrains were sold. On the other hand, the Sous Comité has built up regional storage capacity, and its storage structures are located in some areas where OFNACER does not maintain warehouses.

3. Sous Comité Storage.-- The Sous Comité owns about 11,500 metric tons of capacity in the northern region and about 3,000 metric tons near Ouagadougou. It is possible that in the case of storage facilities located in Ouagadougou, some temporary shifts tend to take place between the two public agencies, OFNACER and the Sous Comité. As shown in Table V-4, the bulk of the Sous Comité's storage facilities are located in the northern ORDs of Yatenga and the Sahel. Both ORDs are traditionally net importers of cereals. The corrugated and concrete structures, 200-300 square meters in area with a total capacity of 11,500 metric tons, were initially used as warehousing for stocks acquired under the Comité's National Grain Stock Reserve Program. The Sous Comité's storage capacity in the northern ORDs has been replaced by the acquisition of materials for the construction of sealed silos. As indicated below, a build-up of stocks occurred under this program between 1974 and 1977. Since that time, these stocks have been drawn down and the structures in the northern ORDs represent, for the present, unused capacity.

4. Private Sector (off-farm) Storage.-- The major characteristic of private sector grain storage is decentralization. It is believed that the private commercant stocks small quantities of 10-40 tons on the average, in any given location. Some informed judgements place the average stock quantity closer to 100 metric tons. The differential may be ex-

TABLE V-4

SOUS COMITE: CONVENTIONAL STORAGE INFRASTRUCTURE IN THE NORTHERN ZONE
(in metric tons)

		I. Corrugated Structures[1]		II. Concrete Structures[2]		
ORD	District	Number	Surface	Number	Surface	Total
Yatenga	Ouahigouya	5	1,000	-	-	1,000
	Sougo	1	200	-	-	200
Yatenga	Titao	2	400	3	900	1,300
Sahel	Djibo	-	-	6	1,800	1,800
Sahel	Arbinda	2	400	3	900	1,300
	Gorgadji	1	200	-	-	200
Sahel	Dori	2	400	9	2,700	3,100
Sahel	Sebba	2	400	3	900	1,300
Sahel	Gorom	2	400	3	900	1,300
TOTAL:		17	3,400	27	8,100	11,500

[1] Surface of each unit measures 200 square meters.

[2] Surface of each unit measures 300 square meters.

SOURCE: OFNACER

plained by seasonal adjustments in stockholdings. It has been suggested that after harvest, commercants buy with a view to storage, and then release grain gradually over the course of the year. Where this holds true, stocks at any point in time reflect the trader's view of price trends, and the average level of stocks held may be subject to sizeable fluctuations.

Current Stock Levels

At the beginning of 1978, public sector foodgrain warehouses had considerable excess capacity. A fall in domestic grain output in 1976/77 brought, as is the normal Sahel pattern, an even greater decline in the marketed volume of grain. Table V-5 gives the evolution of local grain market purchases, imports, and stock positions since 1971. The table shows that grain purchases from the domestic market fell by more than 70 percent between 1975/76 and 1976/77. The grain agency's 1976/77 sales of 22.4 thousand metric tons of millet, sorghum and rice were composed largely of imported grains (foreign aid imports rose by more than 100 percent) and the drawing-down of existing stocks.

The so-called Reserve Stocks held by the Comité National were drawn down in 1976/77. In 1974 and 1975, 5,802 metric tons of grains had been purchased under the first phase of the Reserve Stock program. An additional 3,128 metric tons were purchased under the second and third phases in 1976 and 1977. The initial stock acquisitions were turned over to OFNACER for export to Niger in November and December of 1976. Stocks acquired under the second and third phases of the program were used to meet OFNACER's sales requirements in Ouagadougou in 1977.[1]

In February 1978 OFNACER was reported as holding no stocks from local market grain purchases. Local market sales were reported as being made solely from cereals imported under food aid programs. The Agency's stocks were estimated to be equivalent to approximately one and one-half month's normal grain sales. At this time, the ORDs were also reported to be carrying some amount of grain stocks.[2] The exact level of these holdings has not been determined; however, it may be equivalent to balances indicated in line 4 of Table V-5, less amounts allocated to reserve stocks over the periods shown.

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[1] Ministere du Developpement Rural, Comité National pour la Constitution des Stocks de Cereales de Reserve, Rapport d'Information des Activités du Project, Campagne 76/77 - 77/78, December 1977.

[2] Based on information received from Office of the Entente Fund, Niamey.

CHAPTER VI

GRAIN STORAGE: ISSUES AND INVESTMENT PRIORITIES

In the context of the Sahel economies, there are two levels of grain stocks: 1) on-farm stocks held as reserves by cereal producers; 2) stocks which have been accumulated at the regional levels through the intervention of national grain agencies in cereals markets. The transfer of stocks from production points to centralized warehousing has produced a system, of sorts, for the holdover of stocks in the process of collection and transport.

On-Farm Storage

The quantity of cereals stored on farms, though not known with any degree of certainty, undoubtedly represents for each of the three countries the major proportion of its national cereal stocks and represents equally an established volume of storage capacity which imposes no lien on the public sector. Since investment decisions concerning on-farm storage infrastructure are made by individuals and/or family groups, such investments are costless from the standpoint of national budgetary resources. In the two to three relatively improved harvests since the drought, Sahelian producers have begun to rebuild stocks drawn down in the early 1970. Some observers believe this will continue for several more harvests; and for the immediate future, the distribution, at the margin, of any increasing cereals output among sale, consumption and storage will be reflected in a general increase in on-farm stocks.[1]

Storage Costs

Often in discussions of grain storage, and especially when issues of donor intervention arise, there is a tendency to treat on-farm storage and public sector storage as though they were mutually exclusive elements. Grain stocks stored by subsistence producers, or, in a few cases, by a relatively small number of higher-income, large-scale producers, and stocks which are collected to move in trade, are not mutually exclusive. There is a flow of stocks from farms to off-farm stockholders. All stocks are for some period of time before marketing the responsibility of farmers. Moreover, farmers sometimes draw upon old grain to meet marketing quotas. It may well be that long-term, on-farm holders of stocks practice a policy of stock turnover just as grain agencies plan under their reserve programs. In any event, producers sell grains at periods of the year other than immediately following harvests, drawing upon stocks to meet cash requirements, gifts, etc.

On-farm storage as such imposes a cost on the national economy only to the extent that poor storage practices or inadequately constructed storage facilities reduce the total supply of national stocks; or deterioration in quality (infestation) of grains stored at the farm level causes losses when grains stored on farms for a period of time move in trade. Losses in absolute volume of grains reduce the national stock of wealth represented by the value of the grain, and the deterioration in quality might be viewed as a negative production externality, which carries a social cost when grains enter the marketing system.[1]

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[1] This view of the rebuilding of stocks, at least in those areas within countries which have traditionally maintained high levels of on-farm storage is put forward in IDET-CEGOS, *Etude des Structures des Prix et des Mecanismes de la Commercialisation des Mils et des Sorghos*, May 1976; and, Conseil de l'Entente, *Etude Relative a la Constitution d'un Stock de Reserve en Cereales pour le Niger*, January, 1975.

There is no empirical study which establishes a statistical basis for judging outright losses, or losses in weight or quality of grains stored at the farm level in the Sahel. On the one hand, it is held that within the range of avialable technology, traditional graneries using local construction and fastening materials minimize fixed investment costs, and serve reasonably well in relation to such costs. This sanguine view does not extend, however, to on-farm storage conditions related to pre-storage handling, absence of the chemical treatment of grain, and the like, which is said to impose a high risk burden on primary producers storing grains. Given the magnitude of the loss potential, there are technical experts who hold that substantial returns may be realizable through introduction at the farm level, through technical improvements in pre-storage handling, grain treatment, and perhaps some technological innovation in infrastructure. If the present cost of on-farm storage infrastructure is low relative to other possible techniques, this limits the scope for technological innovation in infrastructure. Opportunities may be wider for improvements in storage methods, insecticide treatment, etc.[1]

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[1] It sometimes used to be argued that stocks held by subsistence producers are destabilizing and accentuate fluctuations in the volume of grains reaching the national market. The argument affected the reactions of farmers to price (income) changes. At low prices, farmers would increase the quantity of supplies in order to maintain a given income, thus further lowering prices. At higher prices, farmers tended to decrease the quantity supplied, taking part of the increased income in the form of increased consumption of the higher-priced product. (FAO, Commodity Policy Price Studies, National Food Reserve Policies in Underdeveloped Countries, Rome 1958.) Such arguments, based on the assumption that the farmer seeks to hold money income constant, are no longer fashionable. In the Sahel, it is accepted that marketed output, at least, is positively responsive to an increase in price. Moreover, the large volume of grains moving as a result of interstate Price differentials weighs heavily in favor of the responsiveness of marketed supply to price.

Traditional graneries, constructed at minimum cost with local materials, facilitate, at their best level of construction, the maximum amount of storage in relation to the individual farm unit's production level, and the maximum duration of storage. Small money outlays are required per ton of grain stored at the farm level. No actual cost estimates have been made for construction of traditional storage infrastructure in the Sahel countries, but there are estimates of on-farm storage construction costs for other West African countries where similar materials are used in construction. Applying these estimates to a fairly typical on-farm storage unit found in Mali permits a simulated cost schedule to be constructed.[1]

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[1] In Niger, for example, technicians have found that a particularly injurious species of beetle has infiltrated national grain agency stocks. It is possible that given the predominant type of on-farm storage structure -- typically a construction employing a straw matting amenable to the breeding of this insect -- infestation may have reached on-farm stocks. This remains a conjecture, since no surveys of farmer stocks have been carried out, but suggests there are returns to be derived from pest control measures.

A recent survey taken by a short-term FAO field team in Mali confirms findings in some other West African countries of an absence of a correlation between losses and the length of the storage period, implying that traditional storage technology is not in itself a cause of storage losses. It is at the field level that substantial grain losses occur. Here, possible measures for improvement include pest control systems, more rapid drying techniques, and improved rack and platform storage. In addition to the technical factors which account for field losses, a second factor is involved, namely, a labor constraint. This is because women are largely responsible for field collection and there are competing uses for labor time. If grains survive the predators, bacteria and fungi to which they are prone during field storage, the traditional ganeries -- if maintained in good repair -- minimize losses. There are two major ways in which traditional graneries could be improved; these are the elevation level of bins and floor reinforcement. (FAO, Rome, 1978.)

The estimates shown in Table VI-1 are based on labor time of one man-day per metric ton of capacity. This coincides with figures which have been cited in Upper Volta. Often, family labor is utilized in the in the construction of graneries, which lowers the cash outlay. But since family labor time has value in alternative uses, it is not inappropriate to value all labor included in construction. In addition to the total cost of 2,420 CFAF shown in the schedule, certain monetary costs such as interest and depreciation charges might be added. For any new storage construction techniques to be effectively introduced as the farm level, the cost cannot exceed the relatively low present cost of on-farm storage infrastructure. Any higher cost must bring about a reduction in storage losses significantly greater than the increase in total costs of new construction methods and materials.

Community-Village Level Storage

There are two factors which place a limit on the scale of stored output located on-farm. The first concerns the scale of production of the

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[1] Estimated costs are based on a classical bin raised off the ground on wooden stilts or stones, made of clay and reinforced with straw. The roof is of straw matting. In such structures access is either through the top or through a wooden door. On the average, bins are about two and one half meters in diameter, sometimes compartmentalized to store different products such as millet panicles, maize cobs, etc. Such bins when found in the Dogon area are built on a slab of rock and raised on a rock footing. This firm base and elevation contributes to the relatively greater efficiency of Dogon storage.

TABLE VI-1

EXEMPLARY CONSTRUCTION COST SCHEDULE FOR ON-FARM STORAGE STRUCTURE

1. Size: 5 Metric Ton Capacity
2. Estimated 4-5 days total labor time

Type of Charge	Cost (CFAF)
1. Mason charges	920
2. Labor costs Includes: a) Soil mixing and preparation b) Transport of clay, water, etc.	1,200
3. Roofing	300
TOTAL:	2,420

SOURCE: Based on data of estimated traditional storage cost in V.K. Nyanteng, The Storage of Foodstuffs in Ghana, 1974.

farm unit itself. Given the average production of farms, taking into account the distribution between the marketed share of output and the amount to be stored for home consumption, and/or release over time, the farm has an optimum level of needed storage capacity. In general, grain storage units of 1-10 metric tons provide sufficient storage space for on-farm needs. This implies, parenthetically, that any modernization of facilities to be introduced at the farm level must take account of the optimum scale of on-farm storage requirements. The second point concerns technological or engineering limitations of traditional graneries. The type of construction materials used in the traditional sector place an upper limit on the storage capacity of a given unit. The design quality of a traditional storage unit is determined by the strength of the flooring and the height above the ground. Weight beyond a certain limit narrows the distance between the structure and the ground. The technology of traditional grain storage structures limits carrying capacity to about ten metric tons.

Collective or cooperative storage systems at the village level have come under discussion partly because of the economies to be derived from storing on an organized basis in a central store or silo (e.g., to spread the overhead costs of supervision, maintenance, insecticide treatment, and to benefit from longer occupancy rates), where individual farm unit structures would be too small in scale to efficiently administer a program. In part, the discussion concerns the introduction of innovations in relatively small-scale storage infrastructure, which would not be economically feasible where the volume to be stored is as low as ten metric tons per unit of storage. The minimum volume of grain required to justify the

TABLE V-5

OFNACER GRAIN PURCHASES, IMPORTS, SALES AND STOCK POSITION 1971/72-1976/77[a]

(in thousands of tons)

	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
1. Local Market Grain Purchases	1.54	0.76	2.77	15.40	25.70	6.21
2. Imports of Grain (foreign aid)	35.29	27.41	29.54	24.75	3.00	7.36
3. Local Market Grain Sales	30.75	24.93	33.02	28.01	13.00	22 36
4. Changes in Grain Stocks (1. + 2. minus 3.)	+6.08	+3.24	-0.71	12.14	15.70	-8.79

[a] Estimated by OFNACER as of February 1978

SOURCE: IMF *Report* on Upper Volta, 1977 employment of more costly construction techniques would be secured by amassing the stocks of individual farmers.[1] The concept of village-level stores is linked as well to official marketing objectives. Cooperative or village storage depots are viewed as a means of drawing on farm stocks, making them accessible to trading. Such a scheme has been put forward in Upper Volta, and while the scheme does not propose to introduce innovations in storage infrastructure, it is examined below in some detail because it raises issues of what the true benefits to the farmer are in collective storage.[2]

The village level storage scheme in Upper Volta is linked to current proposals to strengthen the rural cooperative in order to use the organization as the primary collection agent for the official marketing system. This is, as discussed above, because the ORDs have paid little more than lip service to their assigned role as grain collection agents. A project to be financed under the Fund du Développement Communautaire involves the creation of what is called a Village Cereals Bank. The local cooperative or groupement villageois would construct a number of small, traditional graneries in each village, and bear the responsibility for maintenance and overall supervision of stocks. At harvest, the cooperative would buy grains from individual members at an official producer price of 25 CFA F per kilogram, to consitute the stock. It is during the period of the soudure that the banking element enters the scheme. Members would be entitled to draw grains on credit, equal to a stated percentage of the amount the farmer had originally sold, with repayment due at the next harvest. Repayment would be in kind, i.e., in cereals, and would be increased to include an amount equal to a pro-rated share of storage costs and interest on the loan from the FDC. It will be noted that such a scheme requires that farmers use the credit facilities during the soudure in order to generate sufficient earnings to pay off the loan.[1]

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[1] The argument is also made that village stocks are subject to better loss control than stocks maintained by government at a higher level supervised by a disinterested bureaucracy.

[2] GOUV, Ministry of Rural Development, Information Report on Project Activities, December, 1977.

Whether farmers could be induced to participate in the storage scheme would depend on the benefits they could expect to receive. Its proponents argue that farmers would benefit from the differential between the cooperative producer price of 25 CFA F kilogram for millet and sorghum (set at 4-5 CFA F over the prevailing official price) and the price that could be obtained from any private trader. Yet the scheme as it is conceived has overtones of a "company store" arrangement. Some hypothetical transactions set out below show why this is so.

Example 1 shows the transactions of a single farmer who, in the first year, markets 500 kg of cereals to the local cooperative. He earns 12,500 CFA F on the marketed share of his output. At the beginning of the soudure, he draws out 250 kg from the cooperative. If, in the following year, his production remains constant, and his share available for marketing remains the same, a portion of his 500 kg must be used to repay his debt of the previous season, plus interest charges. This reduces his cash earnings by something more than one-half over the previous year.

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[1] Implicit assumptions are that the farmer's production remains constant and his "marketed" input includes some shift between off-farm and village collective storage.

EXAMPLE 1

HYPOTHETICAL TRANSACTIONS OF A FARMER UNDER A VILLAGE STORAGE SCHEME

Interest rate = 5 percent

Year I.	(Debt owed) Repayment	Sold	Borrowed	Price per kg.	Earnings from Grain Sales
Harvest	-	500 kg	-	25 CFAF	12,500
Soudure			250 kg		
Year II.					
Harvest	262.50 kg	237.50	-	25 CFAF	5,937
Soudure			250 kg		
Year III.					
Harvest	262.50	237.50	-	25 CFAF	5,937
Soudure			250 kg		
Year IV.					
Harvest	(262.50 kg)	-		-	0
Soudure			250 kg		

Debt outstanding at beginning of 5th year = 525.00 kg.

On the assumption that production remains constant, these transactions are repeated in the third year. But, suppose the farmer's production would fall, and the share of output available for marketing declines. If this occurs, the farmer ends up in debt to the cooperative. In the fourth year it is assumed that production declines to the point where his home consumption requirements leave him no output for marketing. His cash earnings fall to zero. If he is required to pay his outstanding grain debt of 262.50 kg to the cereals bank, his own-consumption balance may be negative. If his indebtedness is forgiven, and he is allowed to again borrow against the soudure, his outstanding loan balance will amount to 525 kg. If, in the next year, production returns to the same level as in the years preceding its fall, and if the farmer is required to pay the full value of his loan, his cash earnings again will be zero. Whatever arrangements are made for repayment, the farmer could remain in a state of continued indebtedness at the village cereals bank, and might well end up in a situation where he "owes his soul to the company store".

Another question related to the disposition of the bank's assets, i.e., the grain stocks purchased from farmers. The project document suggests that "once farmers gain confidence in the scheme" sales of grain stocks will be carried out under ORD supervision. Local cooperatives will transfer stocks to warehouses located in the chef lieux of the departemnts for sale by the cooperative association. Thus, when local production falls, there is no assurance that the farmer can expect to have current consumption needs covered by grain stocks placed in cooperative storage. The hypothesis underlying the village bank grain stock position in Example 2 is that the bank will only hold stocks at a level sufficient

EXAMPLE 2

VILLAGE BANK GRAIN STOCK POSITION, 4-YEAR PERIOD
in kg

	(A) Receipts: i=Purchases ii=Repayment III=Loans due	(B) Disbursements during soudure	(C) Sales	(D) Balances[1]
Year 1.	i=500	-250	--	250
2.	i=237.50 ii=262.50	-250	250	250
3.	i=237.50 ii=262.50	-250	250	250
4.	iii=262.50	-250	--	0

Real balances (f) (receipts minus disbursements and sales).

to cover [illegible]rmers cereal requirements during the soudure. If local storage is to be encouraged, schemes must be structured to insure that the farmer gains under a collective storage system, not only in its initial phase, but taking into account the possibility of variation in his level of production. Moreover, sales from collective storage schemes should be deferred until some minimum level of stocks are acquired. It is unlikely that farmers will participate in collective storage unless there is a grain reserve element built into the program, since the reserve element is a primary motivation for on-farm stockholding.

National Storage Objectives

National storage objectives in the three interior countries fall roughly into three categories: 1) a grain stock to meet consumption demands of off-farm populations and deficit areas; 2) a grain supply to stabilize prices over the soudure and between successive years as production fluctuates; 3) a long-term reserve of grain to meet secular shortfalls in production. The first and second objectives, insofar as grain storage facilities and stocks are concerned, are intermingled. The major issues relating to intra-annual price stabilization and the feasibility of buffer stocks for inter-annual price stabilization fall into the area of price and marketing policies. This section takes up issues relating to the first and third objectives.

Location of Storage Infrastructure

If a storage network is to contribute to the global flow of cereals, attention must be given to the optimum location of facilities, as well as to marketing and price policies. Grain agencies, charged with the responsibility of meeting consumption requirements of non-cereal producers, and rural consumers in deficit areas have the problem of reaching consumers at minimum selling and transport costs. In the case of grains, where the product is low in value per unit of weight, shipments -- except for short distances -- result in transportation costs which form a substantial amount of the delivered price.

The general features of the consumption and production maps of the interior countries are well known. In each country, agricultural production tends to be concentrated in a few regions, with substantial distances between major grain-exporting and grain-importing regions, imposing heavy transport and collection costs on grain purchasers. National grain agencies, buying in all regions, first move stocks from production points to central collection locations. In Mali, for example, grain stocks move, on the average, 125 kilometers from villages to the *chef lieux* of the *cercles*. These stocks are again transferred on the basis of geographical consumption and production patterns. In Niger, the grain agency pays, on the average, 6,000 CFA F per metric ton on interregional grain transfers. In general, it can be assumed that true selling and transport costs are not borne by cereal consumers. In part these costs may get shifted backward to cereal producers (to the extent that producer prices are reduced in order to maintain a given consumer price, especially in the case of lower-cost producers), or in part, shifted to the general taxpayer to the extent that the grain agency's overall deficit is covered by budgetary transfers.

Should public grain agencies ever pick up a significant proportion of the grain trade and become primary buyers and sellers in the market, warehousing and distribution systems will be critical to their efficient operation; an accounting must be made of the relative costs which prevail under differing warehousing and storage locations. Such an analysis requires a concept, for example, of "market area." Except for national capitals and large towns in regions, the geographic boundaries of market areas is difficult to define. Markets are spread over large distances, dispersed and isolated. They are characterized by a lack of uniformity in the distribution of consumers over distance and by low population densities. Further characteristics of these markets are the lack of comsumer mobility, and the fact that transport costs are probably linear, i.e., transport cost increases at an equal rate from production locations to selling locations. At present, there is an imperfect and generally unplanned distribution of national warehousing. In particular there is a lack of storage facilities in chronic deficit-production areas; a better geographic location of grain inventories is a priority requirement under a comprehensive storage strategy. A rational price policy could contribute to an optimum location of grain stores as well. A differential in producer prices, which would take into account higher collection and transport costs in less accessible production areas, might serve to promote private grain storage in higher supply-cost regions.

The Long-Term Grain Reserve Program

Post-drought planning in the Sahel has included planned investments in grain stocks and facilities in order to provide a floor under cereal consumption in the event of a series of poor harvests. As the country surveys have indicated, immediately after the drought governments began to build up long term reserve stocks. Between 1974 and 1977 Upper Volta had built up 8,900 metric tons of millet and sorghum; Mali had a total of 18,000 metric tons; Niger, a total of 15,000 metric tons. Except in the latter case, these stocks were drawn down within three years of their accumulation, so that as of the beginning of 1978 there were no security stocks in Mali or Upper Volta.

In all three countries security stock programs were initiated as soon as agricultural production rebounded in 1974, and in no instance has detailed long-term grain reserve planning been carried out. Reserve levels have been set on the basis of some general objectives which include providing for the consumption needs of certain populations for a period of time in the event of a shortfall in production. What has been lacking is a detailed examination of the marketing and price policy issues implicit in such programs, and the institutional and structural strategies required to support reserve programs. An a priori assumption has been made that national welfare would be best served through a country's accumulation of long-term reserves, and that the strategy would be an efficient means of balancing a rainfall-dependent grain production sector. Thus, numerous questions have remained unaddressed in formulating grain reserve policy, among which are these:

i) Price Policy Coordination.-- What are the inter-relationships between stocks acquired and sold under the reserve programs and price stabilization stocks? How responsive is the supply of marketed output at prevailing producer prices?[1] Are present producers of cereals expected to subsidize future cereal consumers -- as a result of the current price structure -- when supply and demand conditions will have changed?

ii) Institutional Structure.-- What are to be the institutional arrangements for control and authority over reserve stocks?[2] What structural changes are envisioned if public grain agencies are to manage reserve stocks? At present these agencies are understaffed, underequipped, and possess limited management-related inputs. To date grain reserve programs have been largely dependent upon foreign technical, as well as financial, assistance.

iii) Storage Technology.-- The appropriate long-term storage technology for foodgrains under Sahel climatic conditions is not known. The butyl silo has been adopted as an intermediate or stop-gap technology in all countries, and is assumed to be the most economical form of storage technology under current conditions. The assumption is that coarse grains can be stored in such structures for three to five years, but there has not yet been a test of this length of storage, and the technology remains unproven.

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[1] E.g., in Upper Volta the Comité National pour la Constitution des Stocks de Reserve reported a liquidity position at the beginning of 1978 of 41.0 million CFAF. But under present grain marketing arrangements and price policies it is questionable whether the Comité will be able to replace stocks which have been sold off.

[2] It is of interest to note that in Niger, where no reserve stocks have been released -- despite recurring production deficits and continued claims on international food assistance -- only the President has the power to draw upon grain reserves.

iv) Locating Reserve Stocks.-- What studies have been undertaken to determine the optimum location of stored reserves?

Such fundamental questions as these indicate that there is much planning and policy-decision making to be carried out if reserve programs are to serve as a drought defense mechanism in the Sahel countries. Moreover, the financial and capital investments involved in this type of venture are not negligible. Some indication of capital and operating costs are indicated in Tables VI-2 and VI-3. These estimates were drawn up for Upper Volta but adequately reflect general magnitudes of costs for the two other countries when applied to a given quantity of stocks.

Levels of Grain Reserves

Table VI-4 shows reported planned reserve targets and stock positions for the three countries at the beginning of 1978. There is no firm basis for judging how reserve targets have been derived. For example, a statistical exercise prepared for the internal use of the grain agency in Mali suggests that the reserve target should be limited to coarse grains, and to a maximum of 70,000 metric tons.[1] The estimated optimum level is arrived at by taking the differential between a so-called normal production year and the level of production realized in any one drought year, in this case 1973; this calculation yields a gross maximum deficit of 333,000

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[1] OPAM, Determination de la Quantitité Necessaire pour le Stock de Sécurité de Mali, undated.

TABLE VI-2

EXISTING AND PLANNED INVESTMENT IN STORAGE INFRASTRUCTURE FOR LONG-TERM GRAIN STOCKS

(in metric tons)

A. Realized:	11,000 MT (Sealed silo capacity)
Estimated Construction Cost:	35,000 CFA per square meter
B. Planned:	
(i) 1977/78	9,000 (includes proposal to build 1,500 MT for bulk storage)
(ii) 1980/81	11,000 (construction to represent replacement of existing capacity of 11,000 sealed silos)
Total planned capacity:	20,000
Total estimated costs (includes equipment)	113.0 million FCFA on 7,500 (sealed silo capacity) 42.0 million FCFA on 1,500 (in bulk)

SOURCE: Ministere du Developpement Rural, Upper Volta, Comité National pour la Constitution des Stocks de Cereales de Reserve, Rapport d'Information des Activites du Projet, December 1977.

TABLE VI-3

BREAKDOWN OF ESTIMATED FINANCIAL COSTS: 9,000 METRIC TONS OF RESERVE STOCKS (245 FCFA=$1)

	Cost in Millions of FCFA
1. Investment in facilities:	
7,500 MT (conventional storage in sacks)	113.0
1,500 (bulk storage plus equipment)	42.0
2. Operating Expenses	
Includes machinery, stock protection equipment	12.0
Transport equipment	60.0
3. Administrative personnel	9.0
4. Training costs	15.0

SOURCE: Ibid.

TABLE VI-4

PLANNED GRAIN RESERVE TARGETS: FIRST QUARTER 1978
(metric tons)

		Type of Grains		
Country	Tonnage	Rice	Coarse Grains	Realized
Mali	80-100,000	60,000	20-40,000[1]	-
Niger	25,000	-	25,000	15,000
Upper Volta	20,500	-	20,500	-

[1] Includes 2,000-3,000 tons of maize.

SOURCE: Ibid.

metric tons. The observed deficit is assumed to provide a measure of future production shortfalls, implicitly assuming that no changes in production technology will have occurred between past and future droughts. It is next assumed that on-farm storage will cover approximately 80 percent of the projected deficit of 333,000, i.e., storage on farm is equal to about 30 percent of a normal year's production. The remaining 20 percent of the deficit, which represents the 70,000 metric tons, would be met by the national Plan objectives had originally projected a reserve stock target of 95,000 metric tons, which included an allocation of 25,000 metric tons to the private sector, presumably meant to reflect on-farm stocks. Three-fourths of total national reserve stocks, or 70,000 metric tons, were to be held in the form of coarse grains, with the remaining one-fourth in rice. As Table VI-3 indicates, the composition of the reserve stock has been revised to make rice the leading reserve cereal. Among the interior countries, Mali is unique in the proportion of rice in cereal reserve targets.

Stock Composition: Supply

Upper Volta.-- All countries plan to constitute grain reserves from local production. One of the problems facing national grain reserve programs -- and one which will effectively limit their scale -- is the grain agency's ability to purchase a sufficient volume of grains. Table VI-4 shows a planned schedule of millet and sorghum acquisitions drawn up for OFNACER for the harvest years 1978-82. According to this schedule, OFNACER will be authorized to purchase three-fourths of the reserve target of 20,500 metric tons in a single collection season. These projections are probably not realistic. Table V-5 on page 48 supra showed the level of OFNACER's local grain purchases since the drought. In only one year the series have local market purchases substantially exceeded sales. A marked improvement in grain production and a substantial increase in the marketed supply of output must occur in Upper Volta in order to realize the purchasing schedule shown in Table VI-5 for Upper Volta, the feasibility of establishing a long-term grain reserve program is largely dependent upon a revision of its grain marketing system. Until such time as marketing arrangements are better constructed, a grain reserve program will remain largely a paper exercise. Imports of grains, of course, or not ruled out. But it would be more rational to look at the grain reserve program in the context of a comprehensive agricultural production and marketing strategy, and to use a grain storage program as a vehicle to achieve improvements in both spheres.

Mali.-- In Mali, the long-term grain reserve program is in reality two programs: the first is a long-term grain reserve program in rice, and the second is a reserve program composed of the coarse grains, millet and sorghum. The projected build-up of a rice reserve stock of 60,000 metric tons, which in real terms means the purchase of 100,000 tons of paddy, is linked to a rice productivity scheme. In fact, it is probably not incorrect to suggest that for Mali, long-term grain storage in rice provides a vehicle for investment in infrastructure and associated activities in order to develop domestic rice production. In short, investment in rice production, rather than storage infrastructure, is the cornerstone of the policy. The reserve stock is to come from the incremental production produced through rice investment programs.

TABLE VI-5

PLANNED EVOLUTION OF GRAIN RESERVE STOCKS, UPPER VOLTA

	YEAR									
	1977/1978		1978/1979		1979/1980		1980/1981		1981/1982	
	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.
1. Beginning stocks	-	15,500	8,000	20,500	12,000	20,500	15,000	20,000	14,400	20,000
2. Additions to stock during year	15,500	-	12,500	-	7,500	-	5,000	-	6,600	-
Of Which: Local Purchase Imports	15,500	-	12,500	-	7,500	-	5,000	-	6,600	-
3. Distribution during year	-	7,500	-	7,500	-	5,500	-	6,000	-	6,600
4. Changes in stocks end fo period	15,500	8,000	20,500	13,000	20,500	15,000	20,000	13,400	20,000	13,400

Source: Ministére du Developpement Rural, Secrétariat Permanent du Comité de Coordination du Developpement Rural, Projet Stock de Reserve Ouagadougou, Rapport d'Information des Activites du Projet, Dec. 1977.

With this grain storage policy, there is now joined to the controversy concerning the economic costs of rice production and the relative costs of encouraging rice consumption over that of millet and sorghum, a controversy over the economic costs of rice storage. Long-term grain reserves in rice impose greater storage costs than do equivalent amounts of reserves in coarse grains. Rice requires, as well, a different kind of storage technology.

For technical reasons, both capital and operating costs of storage of rice stocks exceed the costs of storage of millet and sorghum. Capital costs are higher because of the higher capacity requirements for rice. It is estimated that for a given physical capacity, two tons of millet and sorghum may be stored to one ton of rice. Thus, rice storage portends a 100 percent increase in capital investment in storage infrastructure in comparison to the storage investment required for an equal amount of the coarse grains.

The differential in capital investment required between grain types arises not only from differing capacity requirements; rice storage requires a different type of storage infrastructure. Within the range of available technology, and given the climatic conditions of the Sahel, the type of structure considered to be the most efficient for long term grain storage is the butyl silo. This structure can be filled with a given capacity of treated grains, then permanently sealed for the occupancy of the stock. The engineering design of such silos and the source of their cost advantage over other forms of storage technology is that they permit the storage of cereals for a period of up to five years (in principle) without continuing maintenance and disturbance of the grain. However, this technology was developed for, and is only applicable to, the storage of coarse grains. Rice is not amenable to such long-term storage. Even under the best conditions, rice stocks require rotation within a period of less than twelve months. This implies that there are greater operating costs associated with rice stocks, since stocks must be turned over more frequently and require continuing maintenance, supervision, and treatment.

A quantative estimate comparing actual costs of rice stocks and stocks of coarse grains made by the grain agency in Mali is as follows:

Quantity	Type of Grain	Est. Cost (MF)
1 metric ton	Rice RN40	135,000
1 metric ton	Coarse grains	60,000

The relative costs of storage as well as considerations of production economics and consumption patterns, suggest that the more rational policy would be to limit long-term reserve programs to the coarse grains. If targets for reserves in the form of rice stocks are realized, the array of marketing and price issues raised in the recent CILSS report will no longer be academic but will take on real world significance.

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GRADUATE TRAINING OF LDC ECONOMISTS IN U.K. UNIVERSITIES --
A STATISTICAL NOTE

Nancy Berg and Elliot Berg*

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CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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Nancy Berg and Elliot Berg*

Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

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ABSTRACT

This paper primarily addresses some aspects of the supply of professionally trained economists from LDCs. It summarizes aggregate data on LDC graduate students in economics in the United Kingdom between 1971 and 1975, showing countries of origin, degrees pursued and awarded, length of study, financing sources. Data are also provided on enrollment trends and failure rates in several universities. LDC students are found to be a relatively high proportion of total economics graduate students (about one-third) but the number of Ph D level LDC economists trained in Britain is small -- 20-25 per year in the mid-70's.

† † † † † † † † † †

Ce document aborde quelques aspects de l'offre en économistes formés professionnellement et provenant de pays sous-développés. L'étude résume brièvement les données rassemblées sur les étudiants de ces pays ayant obtenu leur licence en sciences économiques dans le Royaume-Uni entre 1971 et 1975, donnant les pays d'origine, les diplômes recherchés et ceux déjà reçus, la longueur des études et les ressources financières. Des données sont également fournies au sujet de la tendance des inscriptions et des taux d'échec à l'intérieur de plusieurs universités spécifiques. Il s'avère donc que les étudiants des pays sous-développés représentent un pourcentage relativement élevé du nombre total des étudiants licenciés en sciences économiques (environ un tiers), alors que le nombre d'économistes de ces pays obtenant leur doctorat en Grande-Bretagne est faible - 20 à 25 par an vers la moitié des années soixante dix.

In less developed countries (LDCs), economics is widely regarded as an important field and trained economists are high on everybody's list of key professionals. Economists everywhere would share this view, and even some non-economists might find it reasonable. Within governments, after all, economic analysis is, or should be, a critical input to policy making and programming. In universities, courses in economics are central to the social science curriculum and are particularly basic to teaching in management and administrative sciences.

Well-trained professional economists are generally thought to be in short supply in most of the less developed world. Manpower surveys invariably mention economists and people in economics-related fields as being scarce, and casual observation bears this out: there exists a continuing demand for expatriate economists in government agencies and university faculties in many parts of the Third World.

In many LDCs, advanced training in economics is obtained abroad. This immediately raises a variety of interesting issues -- for example, those relating to the *kind* of economics training appropriate for those who will work in the special environments of the LDCs. It also raises questions about the process itself -- questions of a straightforward factual kind, such as how many graduate students in economics are coming along, how long their training takes, how they perform, and more fundamental questions about how well the process of foreign training works.

It is to the latter set of questions that this paper is addressed. The impetus for the study on which it is based is derived from two preoccupations. The first is the slow pace at which indigenous professional economists seem to be emerging in some Third World countries. The second is a body of experience in some American universities, where failure rates of Ph.D. candidates in economics from LDCs have been high, often with disastrous consequences. Students from LDCs frequently enter Ph.D. programs with less background in mathematics and theory than their fellow students from more developed countries. They may also come with language disadvantages. They spend two or three years -- sometimes more -- concentrating on math and theory. Then a relatively high proportion fail the screening examination which would allow them to go on to dissertation writing and the completion of their degree. The students leave not only without a degree, but without much economics. Their self-image, perhaps even their job prospects, have been diminished. Much money, time and effort have been wasted.

In universities where this scenario unfolds, faculties of economics tend to grow reluctant to accept high-risk candidates from LDCs. Access to advanced degrees in economics becomes more restricted for LDC students.

It was to determine whether a similar pattern could be observed in British universities that we initially undertook this study. For a variety of reasons we couldn't do the study as planned, and were therefore unable to conclude whether and to what degree there were similarities in British and American experience in these matters. In the course of the effort, however, we did manage to uncover a certain amount of basic information on economics training for LDC graduate students in the United Kingdom, and on some related questions. The paragraphs below have the quite modest goal of setting out this information, which is not readily available elsewhere; indeed no comparable data exists for the U.S.

The paper has three parts: the first is a brief analysis of the size and composition of economics faculties in LDCs, mainly in British commonwealth universities. The basic data are drawn mainly from the Commonwealth Universities Yearbook. The purpose is to get some insight into the question of how far indigenization of faculty has proceeded in economics, and also to discover what the sources of training have been for these university economists.

The second part of the paper summarizes aggregate data on LDC graduate students in economics enrolled in U.K. universities, between 1971 and 1975. These data are drawn from the Universities Statistical Record, the central record-keeping organization for higher education institutions in the U.K. The U.S.R. has extensive data on enrollments in U.K. universities and on student characteristics, making it possible to determine numbers of students in different disciplines by country of origin, as well as such information as degrees awarded, length of stay at the university, financial aid sources, and first destination after leaving the university.

The third part of the paper presents data available from individual institutions, in particular the London School of Economics, a major producer of economists. For LSE we were able to find enrollment and pass/fail data from 1952/53 to 1975, and applications and acceptances for the period 1972-75.

Also, graduate study at LSE has been the subject of a 1966 study, which provides interesting supplementary data on overseas students.[1] Some pass/fail data also were provided by Oxford University.

I. Levels and Sources of Training of University Economists in Commonwealth Universities

Universities in LDCs are major users of professionally-trained economists. Some insight into the numbers and "quality" of indigenous economists can be obtained by analyzing the origins and credentials of the Economics faculty. Since these data are available for commonwealth universities for various years, it is also possible to say something about trends in training. The source of these data is the Commonwealth Universities Yearbook.[2] We examined the faculty lists (economics) for all universities in commonwealth LDCs which were included in the Yearbook for 1964 and 1974. India was the only exception because of its large number of degree-granting institutions (sixty-nine Indian universities awarded degrees in economics at the B.A. level or above in 1974). Six sample Indian universities were drawn for this analysis.

Tables I-IV summarize this information. Table V shows data on Francophone West African universities taken from another source. The main points emerging from these tables are as follows:

1. "Localization" or "indigenization" of commonwealth university faculties was not far advanced in 1964, except in South Asia. By 1974, only in East and Central Africa was there a substantial expatriate presence. Table V, which gives economics faculty staffing in the mid-1970s in four French-speaking universities, shows a continuing strong reliance on expatriate faculty in those universities.

2. The 1964 and 1974 figures for commonwealth universities refer to different sets of universities, so caution is needed in generalizing about changes over time. Nevertheless, it does seem

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[1] Howard Glennerster, Graduate School, A Study of Graduate Work at the London School of Economics, Oliver and Boyd, Edinburgh and London, 1966, 200 pp.

[2] Commonwealth Universities Yearbook, 1964, 1974. Institute for Commonwealth Studies, London.

that the very considerable expansion in size and number of economics faculties was achieved without any decline in "quality," to the extent that "quality" is measured by proportion of faculty with the Ph.D. degree.

3. The data in Tables III and IV confirm that advanced training--to the Ph.D. level--is mainly done in non-LDC universities. This is most clearly true for the newer universities in Africa. But even in non-African commonwealth universities only 43 percent of junior faculty obtained their Ph.D.'s at home, and excluding India, only 7 percent did so. Except in Africa, most M.A. level training, however, is locally-provided.

4. Of the 455 economic faculty members in the sample of universities in 1974, a little less than one-third had Ph.D.'s. Of these 141 people, 30 percent were trained in the U.S., 21 percent in the U.K., 33 percent in local universities, 16 percent elsewhere. The predominance of American economics training is stronger among younger economists; as Table III shows, 40 percent of the junior faculty with Ph.D.'s were trained in the U.S., as against 11 percent in the U.K. Senior faculty members are more likely to have received British degrees: 21 percent of senior faculty with Ph.D.'s received their degrees in the U.K. as against 19 percent in the U.S.

TABLE I

Number of Local and Expatriate Economics Faculty at Universities in Selected Commonwealth Countries, Ranked by Extent of Indigenization

Country	No. of Universities Examined	Total No. of Econ. Faculty Members	Local	Expatriate	Unclear	% Local
			1964			
Bangladesh	2	25	25	0	0	100%
India	5	53	53	0	0	100%
Singapore	2	12	8	3	1	67%
Nigeria	2	15	8	7	0	53%
Uganda	1	6	3	3	0	50%
Hong Kong	1	8	3	5	0	38%
Kenya	1	6	2	4	0	33%
Sierra Leone	1	5	1	4	0	20%
Ghana	2	18	3	15	0	17%
TOTAL	17	148	106	41	1	72%
			1974			
Bangladesh	4	76	76	0	0	100%
Sierra Leone	1	5	5	0	0	100%
India	6	84	82	1	1	98%
Singapore	2	30	29	1	0	97%
Hong Kong	3	23	21	2	0	91%
Nigeria	3	47	41	5	1	87%
Ghana	2	26	18	2	6	69%
Malawi	1	6	4	2	0	67%
Uganda	1	5	3	2	0	60%
Tanzania	1	12	7	4	1	58%
Guyana	1	6	3	0	3	50%
Kenya	1	22	9	13	0	41%
Zambia	1	8	3	4	1	38%
TOTAL	27	350	301	36	13	89%

SOURCE: Commonwealth Universities Yearbook, 1964, 1974. The 27 universities for 1974 include the 17 examined in 1964, plus 10 established after 1964.

TABLE II

Origin of Advanced Degrees of Economics Faculty Members in Selected British Commonwealth Countries[1,2]

	1964		1974	
I. Number of Universities Examined	17		28	
II. Black African Universities Examined	7		11	
Senior Faculty	9		35	
Number of Ph.D.'s[3]		5		24
Proportion locally obtained		0%		3%
Number of M.A.'s[5]		5		23
Proportion locally obtained		0%		4%
Junior Faculty	41		96	
Number of Ph.D.'s		11		27 (1)[4]
Proportion locally obtained		0%		4%
Number of M.A.'s		22		73 (1)
Proportion locally obtained		9%		7%
III. Other LDC Universities Examined	10		17	
Senior Faculty	43		71	
Number of Ph.D.'s		32		60
Proportion locally obtained		47%		53%
Number of M.A.'s		42		63
Proportion locally obtained		67%		71%
Junior Faculty	55		148	
Number of Ph.D.'s		10		30
Proportion locally obtained		70%		43%
Number of M.A.'s		49		155
Proportion locally obtained		80%		81%
IV. Advanced Degrees by Origin				
Total Ph.D.'s	58		141	
Locally obtained (proportion of total)		22 (38%)		47 (33%)
US		14 (24%)		42 (30%)
UK		13 (22%)		30 (21%)
Other[6]		9 (16%)		22 (16%)
Total M.A.'s	118		314	
Locally obtained (proportion of total)		69 (58%)		177 (56%)
US		21 (18%)		55 (18%)
UK		22 (19%)		53 (17%)
Other		6 (5%)		29 (9%)
Total Advanced Degrees	176		455	
Locally obtained (proportion of total)		91 (52%)		224 (49%)
US		35 (20%)		97 (21%)
UK		35 (20%)		83 (18%)
Other		15 (9%)		51 (11%)

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[1] Faculty in institute, etc. (Table A)

[2] (Table A) #2

[3] Locally implies at an LDC university

[4] Unclear cases

[5] Number of M.A.'s and Ph.D.'s not equal to total degrees, some faculty members having more than one M.A.

[6] (Table A) #6

TABLE III

Origin of Degrees of Economics Faculty Members at Selected LDC Universities Within the British Commonwealth, by Faculty Rank[1,2]

	1964	1974
Number of Universities Examined	17	28
Total Faculty in Economics	148	350
Indigenous[3]	106	301
Expatriate[3]	41 (1)[4]	36 (13)
Senior Faculty Members Total[5]	52	106
Number with Ph.D.'s	37	84
Proportion of total senior faculty	71%	79%
Where obtained (%)		
US	17	19
UK	23	21
Other[6]	0	7
LDC[7]	60	53
(LDC less India)[8]	(33)	(23)
Junior Faculty Members Total[9,10]	96	244
Number with Ph.D.'s	21	57 (1)[4]
Proportion of total junior faculty	22%	23%
Where Ph.D. obtained (%)		
US	14	40
UK	29	11
Other	24	25
LDC	33	24
(LDC less India)	(7)	(7)
Number with M.A.'s	71	288 (1)[4]
Where M.A. obtained (%)		
US	18	17
UK	15	15
Other	8	10
LDC	59	58
(LDC) less India)	(39)	(46)

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[1] Faculty Institutes of Statistics and Social and Economic Research in Ghana and Nigeria are excluded.

[2] All the universities in each of the LDC Commonwealth countries listed in the Commonwealth Universities Yearbook, 1964, 1974, were included except for India, where the large number (in 1974, some 69 universities gave economics degrees) forced us to select a small sample. Six universities were picked in India, the choice guided by a desire to have some old universities and some relatively new ones. The leading universities, like Delhi, were included.

[3] "Local" and "expatriate" were determined by surnames.

[4] Unclear cases are enclosed in parentheses. When percentages were computed, the unclear cases were ignored.

[5] Senior faculty include Professors, Associate Professors, Readers, Senior Lecturers, Visiting Professors.

[6] Other = European and/or other non-LDC countries except the U.S. and U.K.

[7] LDC = degrees obtained at an LDC university; either the teacher's own university, another university in his country, or a university in another LDC.

[8] Indian figures skewed the distribution, and it seemed useful to look at percentages excluding Indian figures (as well as including).

[9] M.A. and Ph.D. numbers exceed total faculty because some faculty had more than one M.A. degree.

[10] Junior faculty include Assistant Professors, Lecturers, Tutorial Fellows, Visiting Lecturers, Instructors. Five staff development fellows (B.A.'s) from Zambia were ignored.

TABLE IV

Staffing of Francophone African Economics Faculties, 1972-1974

	Rank[1]							
	A		B		C		D	
	Local	Exp.	Local	Exp.	Local	Exp.	Local	Exp.
Dakar 73/74	-	3	1	-	-	2	2	1
Abidjan 74	1	-	-	1	-	4	6	-
Kinshasa 72-73	5	9	4	1	7	2	35	4
Cameroon 73-74	2	-	-	1	2	2	2	4
TOTAL	8	17	10	4	16	20	51	11

[1] Rank:

A	Maitre de Conference	(Professor)
B	Chargé de Cour	(Associate Professor)
C	Maitre Assistant	(Assistant Professor)
D	Assistant	(Lecturer)

SOURCE: Campbell, R. and H. Elliot, The Development of Planners in East and West Africa, a report to the Ford Foundation, 1975, Table 3, p. 18; Table p. 100; Table 7, p. 111.

NOTE: Part-time faculty and visiting instructors ("missionaires") have not been included, though they are important in teaching short term (3-6 week) courses.

II. Enrollments in Graduate Economics Programs in U.K. Universities -- A Statistical Profile

The data drawn from the University Statistical Record, covering all U.K. universities, are presented in Tables V to X.

Table V shows that entering classes of graduate programs in economics in the 37 U.K. universities covered numbered about 1,100 students in the 1972-1974 period. As is true of all the USR-provided data, this excludes those enrolled in courses of less than nine months duration ("sandwich" courses -- special training courses such as those given at the Institute of Development Studies in Sussex, or the short project analysis courses at Bradford and elsewhere). Included, however, are enrolled students aiming at research degrees, and those aiming at no degrees at all, if they are enrolled for a program of more than nine months.

The first and most striking fact revealed in Table V is the high proportion of foreign ("overseas") students to total students in economics. Less than half the entering economics graduate class is made up of U.K. citizens. This high degree of openness is not new, nor is it restricted to economics alone. It reflects Britain's general and continuing commitment to provide abundant opportunities for overseas students. The Robbins Commission survey of graduate students in 1961-1962 found that 50 percent of all full-time social studies post-graduates in Great Britain were from overseas.

What is also striking, however, is the extent to which overseas economics students come from other developed regions. North America, Australia, New Zealand, and Europe provide about 14 percent of the total, and the Mediterranean countries (Greece, Turkey, Cyprus) -- which are counted as "less developed" in Table V -- provide another 11 percent. Only about a quarter of the 1974 enrollees came from the other LDCs. Black Africa, where most university systems are still heavily dependent on foreign staff, and where foreign economists are still highly visible in government agencies, had only some 75 first-year students enrolled in 1974, and Africans generally made up fewer than 7 percent of total enrollment.

A look at post-graduate "leavers" -- those who terminate their student status (Table VI) -- confirms the impression, derived from the enrollment data, of the relatively small production of LDC economists from U.K. universities.

TABLE V

First Year Students Enrolled in Graduate Economics Programs, By Regional Origins, All U.K. Universities, 1972-1974

		1972		1973		1974	
		First Year Student Enrollment	% of Total	First Year Student Enrollment	% of Total	First Year Student Enrollment	% of Total
More Developed Countries	United Kingdom	546	50	511	44	495	44
	Canada, New Zealand, Australia, USA, Europe	165	15	163	14	160	14
Less Developed Countries	Greece, Turkey Cyprus	87	8	113	10	121	11
	North Africa	2	0	3	0	5	0
	Anglophone Africa	48	5	56	5	67	6
	Rhod/SA	7	1	8	1	4	0
	Francophone Africa	0	0	0	0	3	0
	Other Africa	0	0	2	0	4	0
	Asia	113	10	119	10	105	9
	Middle East	66	6	96	8	93	8
	Latin America	42	4	71	6	57	5
	Other	16	2	21	2	16	1
	TOTAL	1,085	100[2]	1,155	100[2]	1,126	100[2]

SOURCE: Universities Statistical Record (USR)

[1] As of December 31 of each year.

[2] Errors due to rounding.

TABLE VI

Number of Graduate Leavers in Economics, by Regional Origin, 1973 and 1974

	1973					1974				
Region	No Award	Masters	Ph.D.	Other	Total	No Award	Masters	Ph.D.	Other*	Total
United Kingdom	102	195	27	36	360 (48%)	124	195	45	28	392 (44%)
Canada, etc.	52	41	14	19	126 (17%)	58	52	12	19	141 (16%)
Greece, etc.	20	22	2	11	55 (7%)	22	42	7	16	87 (10%)
Latin America	12	9	2	7	30 (4%)	22	12	2	7	43 (5%)
Asia	29	27	9	12	77 (10%)	31	36	9	18	94 (11%)
Middle East	11	22	2	6	41 (6%)	16	25	4	19	64 (7%)
Africa	13	22	6	4	45 (6%)	10	21	10	8	49 (6%)
North Africa	1	-	1	-	2 (0%)	-	-	-	1	1 (0%)
Francophone Africa	-	-	-	-	-	-	-	-	-	-
Anglophone Africa	12	22	5	4	43 (6%)	9	21	10	6	53 (6%)
(Rhod/SA)	(4)	(3)	(1)	(1)	(9)	(1)	(7)	-	(1)	(9)
Other Africa	-	-	-	-	-	1	-	-	1	2 (0%)
Other	8	6	1	1	16 (2%)	3	4	1	1	9 (1%)
TOTAL	247	344	63	96	750 (100%)	286	394	90	116	886 (100%)

SOURCE: USR

*Except higher doctorates

LDC economists leaving in 1974 represented 30 percent of all leavers.[1] And in absolute terms, only 111 M.A.s and Ph.D.'s were awarded to LDC leavers in that year. Of these, over 25 were Ph.D.'s; in 1973, 20 Ph.D.'s in economics were awarded. Only 16 Ph.D.'s went to African economics students during these two years, and 43 M.A.'s.

Table VII shows the kinds of degrees being pursued by economics graduate students in the U.K., not only by level (M.A. or Ph.D.) but whether it is a "taught" or "research" degree. In pre-World War II Great Britain, students tended to do course work only at the undergraduate level; frequently for the M.A. and virtually always for the Ph.D., there were no formal course requirements, as at U.S. graduate schools. As the technical content of economics became heavier, and as the career objectives of economics students became more diverse, this presented certain inconveniences. Graduate students from LDCs, particularly, often needed more basic and structured training designed to prepare them better for the increasingly technical kinds of work they might be called on to do at home. Taught graduate degrees were thus introduced at Oxford in 1946 (B. Phil.) and their general adoption was recommended by the Robbins Committee in its 1963 report. By 1972, the proportion of students enrolled in taught programs to total graduate enrollment was 67 percent, rising to 69 percent in 1973 and to 71 percent in 1974 (Table VII). As a corollary to the increase in taught degrees, the proportion of students enrolling for the Ph.D. degree, which is essentially a research degree, fell significantly in that same time period.

In comparing the kinds of degrees sought by students from LDCs and MDCs (More Developed Countries), Table VIII reveals a somewhat higher proportion of MDC students enrolling for Master's and Ph.D. degrees, and substantially more LDC students enrolling for "other" degrees, which include (in addition to those mentioned in the footnote to Table VII) diplomas in Economic Development, Social Studies and other special programs. The proportion of MDC and LDC students working for "no award"--the research fee or independent study students--in this three-year period does not reveal any clear pattern or trend.

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[1] This excludes students from Greece, Turkey and Cyprus, who elsewhere in this paper are included in the LDC category.

TABLE VII

Degrees Sought by First Year Graduate Students in Economics, 1972-1974, All U.K. Universities

	Type of Degree										
Year	Masters		Ph.D.		Others*		No Award		Total		Total Students
	Taught	Research	Taught	Research	Taught	Research	Taught	Research	Taught	Research	
1972	531	186	1	106	173	43	17	28	722	363	1,085
1973	575	192	1	96	196	64	20	11	792	363	1,155
1974	556	172	1	73	191	54	54	25	802	324	1,126

*Others: This category includes graduate bachelor's degrees, B. Phil, B. Lit, etc.; higher doctorates, D.Sc ; other awards of higher degree standard; undecided students; professional teaching qualification.

TABLE VIII

Degrees Sought by First-Year Graduate Students in Economics, by Origin, 1972-74, all U.K. Universities

Origin of Students		Type of Degree Sought				
		Masters	Ph.D.	Others[2]	None	Total Students
1972	MDC[1]	510	78	100	23	711
	LDC	207	29	116	22	374
1973	MDC	484	70	109	11	674
	LDC	283	27	151	20	481
1974	MDC	441	50	107	57	655
	LDC	287	24	138	22	471

[1] U.K. students included

[2] See footnote Table II-3

Sources and extent of financing of Economics graduate students are shown in Tables IX and X.

Well over half the students in the U.K. relied on outside help to finance the main portion of their education in the years 1972-1974. The Black African students were the group most dependent on outside financing: in 1974, over 87 percent had outside help compared with 44 percent of students from the Middle East.

The main source of support was in the overseas countries themselves--universities, government, industry, etc. But British aid ran an important second. Given the fact that in this period fees charged at U.K. universities were relatively low, the extent of British support of overseas students is impressive.[1] Clearly,shifts in the fortunes of overseas countries, for example in the Middle East, will affect the numbers of students coming to study in the U.K. and elsewhere.

Another set of data that has obvious policy implications and interest from the "brain drain" point of view is the destination of students once a degree is obtained. Table XI shows that slightly over half of overseas economics post-graduates in the three-year period 1971-1974 are known to have returned home. There are ambiguities in these data which make them too fragile for analysis -- notably the large number whose destination is unknown, and the possibility -- even likelihood -- of return home after an initial period of employment in the U.K.

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[1] It was only in 1967 that Britain began charging higher fees for overseas students than for home students. In the 1976-1977 academic year, overseas student paid the equivalent of US $740 a year for post-graduate instruction, compared with $324 for British nationals. The British Department of Education and Science recently recommended a fee of $1,335 for postgraduate education in 1977-1978. This has been labelled "a blow against internationalism" by the Council for Overseas Students. Wall Street Journal, August 9, 1976, p. 4.

TABLE IX

Financing of Graduate Students in Economics in the U. K. for the Years 1972-1974[1]

	Total Students	Receiving Financial Aid		Total Students	Receiving Financial Aid		Total Students	Receiving Financial Aid	
		#	%		#	%		#	%
U.K.	546	368	67	511	290	57	495	282	57
Overseas	539	308	57	644	303	47	631	350	56
(of which) LDC	374	234	63	481	247	51	471	265	56
(of which) Black Africa	41	39	95	50	41	82	70	61	87
Asia	113	74	66	119	69	58	105	70	67
Middle East	66	36	55	96	41	43	93	41	44

TABLE X

Sources of Financial Support for Economics Graduate Students in the U. K. (1972, 1974)[1]

Source of Finance	Number of Overseas Students				Number of LDC Students				Number of Black African Students			
	1972	%	1974	%	1972	%	1974	%	1972	%	1974	%
British	113	37	115	33	88	38	85	32	10	26	12	20
Overseas (local)	133	43	183	52	99	42	140	53	15	39	34	56
International Agency	12	4	20	6	11	5	15	6	6	15	8	13
Other	50	16	32	9	36	15	25	9	8	21	7	12
Total Receiving Financing	308	100	350	100	234	100	265	100	39	100	61	100

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[1] All known students financed other than by personal savings, family or personal loan.

SOURCE: USR

TABLE XI

First Destination of Overseas Graduates in Economics, 1972-1974

	Total Graduates	Returned Home	%	Study	Temporary Employment	Permanent Employment	Stayed in U.K. or Unknown[1]
1971-1972	214	109	50.9	3	2	9	91
1972-1973	198	107	54.0	3	1	6	81
1973-1974	265	148	55.8	5	2	14	96

[1] Stayed in U.K. for education, training, a job or are unemployed.

SOURCE: Universities Statistical Record (USR).

III. Data from Individual Universities

As is evident from the previous section, the Universities Statistical Record now has on file in its computer a very substantial body of information on higher education in the United Kingdom -- enrollments, degrees awarded, financial aid, length of university stay, and first destination after leaving the university. It has these and other data by individual university, by country of origin of students, and by discipline. But centralized and standardized record-keeping dates only from 1971. For earlier information, and for other types of data, individual university sources must be drawn on. In this final section of the paper we turn to these disaggregated data, in part to further illuminate issues raised in the country-wide data, in part to explore different questions.

Tables XII and XIII -- based on USR data -- show the distribution of LDC (and African) students among U.K. universities, and the relative importance of LDC graduate students in total enrollments in economics at each of the 37 universities. While the 471 LDC students in 1974 were widely distributed -- only five universities had no LDC representation-- well over half were studying in six universities: London (102), E. Anglia (42), Manchester (39), Bangor (20), Leeds (28), and Oxford (23). Students from LDCs form a big proportion of most graduate programs in economics; in 1973 and 1974 they were the majority in about half the universities.

Table XIII shows where African economics students are being trained. Almost two-thirds of the 74 students from that region (1974) were in four universities: Manchester (11), Bangor (10), London (10), and Strathclyde (9).

Many people have a vision, encouraged by memories of Harold Laski and the speeches of Patrick Moynihan, of the London School of Economics as spawner of socialist Third World economists, the implication being that LSE has been a major training ground for LDC economists. Table XII shows that indeed more than 20 percent of all LDC graduate students in economics in the U.K. were enrolled at LSE in 1974. But enrollment trends, as drawn from the Registrar's records at LSE, suggest a decline in numbers over the decade of the 1960's (Table XIV), and it is quite clear that the proportion of the LDC to total economics students has been declining recently. In the 1950s, 60-80 percent of LSE's economics graduate students were from poor countries. This dropped to under 50 percent by the late 1960's. According to the USR data (Table XII), it had fallen to 25 percent by 1974.

TABLE XII

Distribution of First Year Economics Graduate Students, By University, 1972-74*

	University	1974		1973		1972	
		No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics
1.	UWIST	1	100	2	67	2	40
2.	Stirling	9	82	4	27	4	17
3.	Swansea	11	79	7	58	1	20
4.	Surrey	17	74	15	75	9	53
5.	Bangor	20	71	20	87	10	56
6.	East Anglia	42	68	46	72	23	66
7.	Birmingham	14	67	20	57	5	31
8.	Glasgow	19	66	11	55	21	70
9.	Edinburgh	7	64	2	15	3	21
10.	Aberstywyth	5	63	4	57	2	33
11.	Essex	23	61	16	57	9	39
12.	Keele	4	57	3	50	1	50
13.	York	12	55	4	19	8	30
14.	Lancaster	7	54	16	64	18	37
15.	Exeter	15	54	2	17	4	22
16.	Bristol	8	53	6	46	8	42
17.	Stathclyde	15	52	16	59	12	60

TABLE XII (cont'd)

	University	1974		1973		1972	
		No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics
18.	Manchester	39	48	38	55	36	43
19.	Leeds	28	46	29	48	22	45
20.	Sussex	11	39	17	55	7	33
21.	Oxford	23	36	33	47	24	35
22.	Bradford	1	33	1	33	2	33
23.	Reading	1	33	2	67	0	0
24.	Kent	5	31	9	50	7	30
25.	Cambridge	11	31	17	38	16	36
26.	Southampton	6	30	15	44	11	26
27.	London (total)	102	29	100	28	86	32
	Queen Mary	21	62	11	28	11	32
	University Coll	11	44	2	13	9	56
	Oriental & African Studies	9	43	8	47	7	44
	LSE	53	25	57	25	60	30
	Birkbeck	8	11	5	8	1	20
28.	Leicester	6	29	5	33	1	5
29.	Nottingham	2	29	0	0	0	0
30.	Hull	3	21	6	46	3	18
31.	Warwick	3	20	2	14	3	16
32.	Cardiff	1	14	2	22	3	25
33.	Brunel	0	0	6	19	7	22
34.	Durham	0	0	1	33	2	40

TABLE XII (cont'd)

University	1974		1973		1972	
	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics
35. Liverpool	0	0	1	20	1	11
36. Sheffield	0	0	1	8	1	6
37. St. Andrews	0	0	2	50	2	67
TOTAL:	471		481		374	

SOURCE: USR

***Universities are listed in descending order according to proportion of LDC students to total students (Economics) in 1974.**

TABLE XIII

Distribution of First Year Economics Graduate Students from Africa By University, 1972-1974*

	University	1974		1973		1972	
		No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics
1.	Bangor	10	36	11	48	3	17
2.	Strathclyde	9	31	6	22	7	35
3.	Surrey	4	17	0	0	1	6
4.	Birmingham	3	14	1	3	1	6
5.	Keele	1	14	0	0	1	50
6.	Manchester	11	14	3	4	4	5
7.	Glasgow	3	10	4	20	0	0
8.	Leeds	6	10	4	6	3	6
9.	Edinburgh	1	9	0	0	0	0
10.	East Anglia	5	8	2	3	1	3
11.	Lancaster	1	8	1	4	2	4
12.	Hull	1	7	1	8	0	0
13.	Bristol	1	7	0	0	1	5
14.	Oxford	3	5	3	4	4	6
15.	York	1	5	0	0	0	0
16.	Exeter	1	4	1	8	2	11
17.	Sussex	1	4	2	6	2	10
18.	London (total)	10	3	8	2	10	3
	Oriental & African Studies	2	10	1	6	0	0
	Queen Mary	2	6	0	0	1	3
	LSE	6	3	6	3	8	4
	Birkbeck	0	0	1	1	0	0
	University Coll	0	0	0	0	1	6

TABLE XIII (cont'd)

	University	1974		1973		1972	
		No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics	No. of LDC Students	LDC Students as % of Total in Economics
19.	Cambridge	1	3	2	4	1	2
20.	Essex	1	3	2	7	1	4
21.	Aberstywyth	0	0	0	0	0	0
22.	Bradford	0	0	0	0	0	0
23.	Brunel	0	0	0	0	1	3
24.	Cardiff	0	0	0	0	1	8
25.	Durham	0	0	0	0	0	0
26.	Kent	0	0	0	0	1	4
27.	Leicester	0	0	0	0	0	0
28.	Liverpool	0	0	0	0	0	0
29.	Nottingham	0	0	0	0	0	0
30.	Reading	0	0	0	0	0	0
31.	Sheffield	0	0	0	0	0	0
32.	Southampton	0	0	3	9	0	0
33.	St. Andrews	0	0	0	0	1	33
34.	Stirling	0	0	1	7	0	0
35.	Swansea	0	0	1	8	0	0
36.	UWIST	0	0	1	33	0	0
37.	Warwick	0	0	1	7	0	0
	TOTAL:	74		58		48	

SOURCE: USR

*Excludes north Africa and south Africa. Universities are listed in order of the relative importance of African students in their graduate program in Economics.

TABLE XIV

Non-U.K. Graduate Students in Economics at the London School of Economics, By Degree Sought and Origin, Selected Years 1952-1968[1]

Origin	1952/3					1957/8					1962/3					1967/8				
	Total	MA		PhD		Total	MA		PhD		Total	MA		PhD		Total	MA		PhD	
		#	%	#	%		#	%	#	%		#	%	#	%		#	%	#	%
MDCs	28	12	43	16	57	19	13	68	6	32	48	29	60	19	40	82	58	71	24	29
LDCs	32	25	78	7	22	61	39	64	22	36	83	48	58	35	42	67	49	73	18	27
Total	60	37	62	23	38	80	52	65	28	35	131	77	59	54	41	149	107	72	42	28

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[1] The data in this table came from a different source than the previous tables, and are not strictly comparable. They were compiled from student card file records at the Registrar's Office, LSE. They refer to total enrollments, not first year enrollments as is the case with the USR data.

LSE's role in training African economists has always been modest. As Table XV indicates, there were no black Africans there at all in 1952-53, and only three were enrolled five years later. By 1967-68 there were 94 Ghanaians, 4 Nigerians, and 1 Tanzanian.

Table XVI shows some comparable data for Oxford University which also suggests a declining trend in LDC enrollments over the past decade. Like the LSE data, these show a relatively small African contingent: only three economics post-graduates in 1974. They also show the pre-dominance of Asian students in the LDC group.

How well do LDC degree candidates in economics perform in absolute terms and by comparison with fellow-students from the more advanced countries? It will be recalled that the initial impetus to this study derived in part from the apparently higher failure rate of LDC degree-seekers in some U.S. economics faculties.

Assessment of this question is uncommonly difficult because of such factors as the use of consolation degrees and uncertainties regarding equivalency of degrees and diplomas in terms of quality and content. Also, the USR keeps no specific information on this question. It lists "no award" leavers, but these can be "failed" students, in the sense that they did not succeed in winning a degree, or they can be research students or independents who never intended to get a degree.

At LSE, which is one of two universities for which we have pass/fail data, LDC students compare favorably with MDC students in terms of proportion who pass, particularly for the years 1957-1958 and 1962-1963 (Table XVII). No clear patterns of relative success appear for the MDC and LDC groups over this 15-year period. Data on leavers from LSE in 1973 and 1974 are even less clear, because, as mentioned above, the "no award" category includes failed students and also students who never intended to get a degree. For this reason, the data on leavers are not shown here. For what it is worth, they indicate no noticeable differences between the two groups.

Glennerster noted a few years ago that Asian and African students (all such students -- not just those in economics) not only kept up with MDC students at LSE but performed better in terms of degree performance between 1954 and 1960.[1] His findings are reproduced in Table XVIII.

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[1] Glennerster, H., Op. Cit., p. 43.

TABLE XV

Black African Graduate Students in Economics Enrolled at LSE, By Country of Origin, Selected Years 1952-1967

	1952	1957	1962	1967
Ghana	0	0	1	4
Nigeria	0	2	1	4
Kenya	0	1	1	0
Tanzania	0	0	0	1
Sudan	0	0	2	0

TABLE XVI

LDC Graduate Students in Economics Enrolled at Oxford, By Region of Origin, 1967-68 and 1974-75

Region of Origin	1967-68	1974-75
Greece, Turkey, Cyprus	6	2
Africa	7	3
Asia	23	13
Middle East	6	2
Latin America	8	1
Other	2	2

SOURCES: 1967-68: Registrar, Oxford University; 1974: USR. In 1974-75 total economics enrollment was 64; with U.K. students numbering 21 and those from other MDCs numbering 20.

TABLE XVII

Failure Rates for Non-U.K. Graduate Students in Economics, LSE, Selected Years 1952-1968

Year	Origin	Passed M.A.	Passed PhD	Failed M.A.	Failed PhD	% Failed
1952-53	MDC	9	13	3	3	21
	LDC	15	6	10	1	34
1957-58	MDC	9	4	4	2	32
	LDC	27	20	12	2	23
1962-63	MDC	15	16	14	3	35
	LDC	36	30	12	5	20
1967-68	MDC	47	16	11	8	23
	LDC	34	14	15	4	28

Glennerster suggests that the relative success of overseas students found in his study is due, among other things, to the family pressures to succeed, pressures which are exercised very strongly, and to the need for a degree as a job-getting instrument. These pressures are reflected in Glennerster's finding that overseas students studied more than U.K. students.[1]

The Oxford data (Table XIX) are more complete in terms of pass/fail information. One piece of information of interest here is the fact that of 87 students, 3 took lesser degrees than intended at entrance, and 11 took higher degrees than originally intended.

Thus, the available data do not unambiguously indicate a performance problem for LDC graduate students in economics in the U.K., at least as this is measured by relative failure rates. It should be noted, however, that LDC student failure rates at the M.A. level, which is a taught degree for the most part, are higher than MDC rates in most years. And discussions with faculty members in a number of universities suggest that the problem is not altogether absent. Some of those interviewed indicated that the LDC students in economics did indeed have special difficulties due mainly to the anticipated handicaps of inadequate language facility and mathematical preparation.

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[1] Glennerster, H., Op. Cit., p. 43.

TABLE XVIII

Degree Performance of Overseas Postgraduate Students at LSE, By Regions 1954-55, 1957-58, 1960-61 Entrants

Origin	Results on Ending Higher-degree Registration					
					Percentages	
	Obtained PhD	Obtained Master's	No Degree	Still Registered	All Entrants	No.= 100%
Developed Countries	19	24	51	6	100	157
Less Developed Countries	33	30	31	6	100	145
All Overseas	27	27	40	6	100	302

SOURCE: Howard Glennerster, Graduate School: A Study of Graduate Work at the London School of Economics, p. 43.

TABLE XIX

Oxford University: Pass/Fail Data Postgraduate Students of Economics 1967-1968 by Regions

Region	Number of Students	Passed[1]	Failed[2]	Other[3]	% Passed
MDCs	35	24	10	1	69
LDCs	52	37	14	1	71
Total	87	61	24	2	70

SOURCE: University Registry, Oxford University.

[1] Degree obtained: Degrees include B. Litt., B. Phil., D. Phil., Diplomas in Economic Development, Diplomas in Agricultural Economics, Diplomas in Social Studies.

[2] Includes, "Withdrawn," "Failed Examination," and "Lapsed" (period of time allotted has run out).

[3] Neither failed nor passed; situation undetermined.

It is not possible to know, on the basis of presently available information, whether the anticipated faculty reaction to performance deficiencies -- higher rejection rates for applicants from LDCs -- has in fact occurred. Data on this question could be gathered only for LSE, and is presented in Table XX. Rejection rates are indeed higher for LDC applicants than for those applying from MDCs -- 80 percent during the period 1972-1975 for LDC applicants, 55-65 percent for MDC applicants. No clear trends are evident, however.

Professional training in economics is a particularly critical form of technology transfer. It is perhaps not the same as in medicine, where the content of the doctors' training strongly shapes the health care system; economists like to think that "sound" economic analysis has universal utility and is essential in all economic systems. But relatively little remains known about these matters, about how the process of economics training works in the universities of the more developed countries, or even about how many trained economists from LDCs have been and are being produced.

This paper is no more than a prologue to the serious study of these questions. We have done no more than set out the basic information about the number of Third World students being trained in the universities of one of the major economist-producing countries. The main points emerging from the data have been summarized in the paper. Two points are worth special emphasis.

First, economics faculties in U.K. universities seem decidedly more cosmopolitan, more export-oriented than are U.S. economics faculties. There are no firm U.S. data available comparable to those outlined for the U.K., but casual observation of a number of U.S. Economics Departments and a count of the Ph.D.'s awarded each year (as given in the American Economic Review) suggests that foreign graduate students are appreciably less than the 50-55 percent found in the U.K., and that LDC students are much less than one-third of the total.

Even more casual observation of the French university scene suggests a similar conclusion: that LDC economics degree candidates are a smaller proportion of the total than is the case in the U.K. There is a structural difference in France, however. In the French system there are

TABLE XX

London School of Economics
Number of Acceptances and Rejections to Postgraduate Economic Programs for 1972 - 1975 by Regions

Region	1972				1973				1974				1975*			
	Accept	Reject	Total	% Accepted	Accept	Reject	Total	% Accepted	Accept	Reject	Total	% Accepted	Accept	Reject	Total	% Accepted
Britain	120	118	238	50	123	101	224	55	117	82	199	59	79	90	169	47
Canada	27	20	47	57	23	39	62	37	22	23	45	49	14	24	38	37
United States	66	82	148	45	49	91	140	35	47	81	128	37	44	63	107	41
Europe	36	88	124	29	37	90	127	28	52	135	187	28	34	137	171	20
Austrailia/N.Z.	12	8	20	60	13	5	18	72	23	7	30	77	6	9	15	32
North Africa	0	5	5	0	0	2	2	0	0	3	3	9	1	2	3	33
Black Africa	36	35	38	8	3	38	41	7	11	25	36	31	3	33	36	8
South Africa	3	1	4	75	0	5	5	0	4	3	7	57	2	3	5	40
Latin America	18	55	73	25	13	40	53	25	14	69	83	17	11	37	48	23
Asia	30	107	137	22	34	92	126	27	30	117	147	21	29	115	144	20
Middle East	19	93	112	17	18	68	86	21	13	109	122	11	17	90	107	17
West Indies/Other	1	7	8	13	1	11	12	8	3	6	9	33	3	3	6	40
TOTAL	335	619	954	35%	314	582	896	35%	336	660	996	34%	243	606	849	29%

SOURCE: London School of Economics, Registrar's Office.

*"Rejected" includes those for whom no decision had been made at the time of this study.
"Accepted" includes conditional acceptances, the conditions for which were yet to be met.

a host of special "diploma" and "certificate" courses specifically intended for overseas students. So while the LDC students in regular (License and Doctorate) programs seem to be relatively thin (compared to the U.K.). The numbers in special programs are much larger than in the U.K.

Secondly, despite the relatively larger place given to LDC students in U.K. universities as compared to those in the U.S., the absolute numbers remain small. If we assume that for most people it takes a Ph.D. or its equivalent to reach a "professional" level of technical competence, then the 20-25 Third World Ph.D.s produced annually in the U.K. in the mid-70's cannot be regarded as very substantial. For all of Africa there were only 16 Ph.D. leavers in the two years 1973-1974. In the U.S. the numbers are surely larger, but perhaps not much larger. Many of these new professional economists will be sought by MDC universities, and by the international organizations, so the total annual flow into the LDCs themselves, particularly in Africa, must still be terribly small.

That there is something here to be concerned about should be evident to all development practitioners. Everyone knows that one of the most damaging deficiencies in LDC public policy-making is the scarcity of technically sound policy analysis, the lack of good economic staff work in operating agencies, planning ministries, budget bureaus and finance ministries. These scarcities cannot soon be removed if well-trained economists are not forthcoming in greater number.

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THE POTENTIAL IMPACT OF INTERNATIONAL TRADE AND INVESTMENT SANCTIONS ON THE SOUTH AFRICAN ECONOMY

by

Richard C. Porter

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CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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Richard C. Porter

ABSTRACT

The purpose of this paper is to clarify the theory of international economic sanctions and to provide estimates of the short-run economic impact on South Africa of externally imposed reductions in the imports and capital flows into that country. Several theories of how sanctions "work" are examined, and they are shown to be not all equally plausible and not all consistent with each other. A macroeconomic picture of South Africa's "dependence" is drawn, and the economy's point of vulnerability in the short run is seen to be in its capacity to import, not in exports or capital flows. Finally, a static linear programming model of the South African economy is constructed. This model estimates that small sanctions would have small impact -- i.e. if imports were reduced by less than one-fourth, GDP would be cut by only about one-half as large a percentage as imports. Larger import reductions cause ever greater damage. And if imports were cut in half, not only would GDP be seriously reduced but massive unemployment and relocation of white labor would occur.

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THE POTENTIAL IMPACT OF INTERNATIONAL TRADE AND INVESTMENT SANCTIONS ON THE SOUTH AFRICAN ECONOMY

Richard C. Porter[1]

I. Introduction

For some time, and with increasing frequency, sanctions have been suggested as a means whereby the world community might force changes in South Africa's racial policies. But the resulting debate has been hampered by a lack of clarity about how sanctions are supposed to function and by a nearly total absence of refined empirical estimates of the potential impact of sanctions. The goal of this paper is to alleviate those deficiencies.

The word "sanctions" covers a wide variety of international actions.[2] Here, we shall consider only one set of such actions, where South Africa's international trade of goods and factors of production is impeded by agreement among its trading partners. Thus, the initial impact of international sanctions - or boycott, or embargo, the words are here considered synonyms - is upon South Africa's exports, imports, and net inflow of foreign capital; the ultimate incidence is, as well, on the volume, structure, and growth of South African output, income, and employment.

The theory of how sanctions "work" is developed in Section II. Not surprisingly, the received literature displays a variety of theories, not all equally plausible and not all consistent with each other. A broad picture of South African "dependence" is drawn in Section III, and a macroeconomic assessment made of what kinds of sanctions do and do not have a potential to damage South African welfare. The source of the potential damage is seen to be the deprivation of imports. A sectoral model is then constructed and simulated in Sections IV and V in order to generate quantitative estimates of the potential short-run impact of import reductions. The conclusions of these simulations, stated more fully in Section VI, are essentially that small import reductions would have small impact but that significant import reductions would cause nearly proportionate reductions in South Africa's output plus extensive white labor relocation and unemployment.[1]

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[1] Department of Economics, University of Michigan. For their careful work on the data and the computer, I am indebted to A. Beyaert, K. Maskus, and J. Tempalski. For helpful comments in an earlier draft, I thank R. Barlow, T. Bell, E. Berg, W. Cotter, A. Deardorff, D. Myers, and M. Nziramasanga. I am also grateful to the Ford Foundation for its financial support.

[2] For a sampling, see Ferguson and Cotter, 1978.

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[1] There are four appendices. In Appendix A, the model of Sections IV and V is fully displayed. In Appendix B, the derivation of the data and of the parameters of the model is described. In Appendix C, the sectoral production functions of the model are developed in detail. And in Appendix D, previous work on sanctions using input-output models is examined closely.

II. The Theory of Economic Sanctions

Although economists have written extensively about universal economic sanctions, the precise mechanism whereby sanctions are supposed to prove effective is not always clear, and several quite different mechanisms can be discerned in the received literature. The goal of sanctions is clear and simple: to impose a reduction in economic welfare on the target country and thereby reduce its willingness to persist in antagonizing the world community. But even for this simple statement, two complexities should be noted. First, the "thereby" is critical, although there is neither logical reason nor historical evidence that political or psychological collapse inevitably follows economic hardship, no matter how great that hardship.[1] Nonetheless, I intend to ignore this essentially non-economic issue and focus on the link between the international imposition of economic sanctions and the ensuing loss of economic welfare. The second problem lies in the words, "target country." This simple concept is adequate only if we deal with a homogenous population, with each member identically affected by sanctions, which reaches policy decisions by consensus. In any application of sanctions to South Africa, it must be remembered that the target is white South Africans' welfare;indeed,the true objective presumably would be to reduce the sum of white South Africans welfares, individually weighted by their importance in the political process.

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[1] Much recent evidence comes from North Vietnam: "...the argument that the bombing would affect the will of Hanoi's leadership is generally based on three suppositions. First, the bombing would so reduce North Vietnam's capability to successfully prosecute the war that Hanoi would either sue for peace or substantially reduce the level of warfare. Second, the leadership would decide that the level of destruction visited upon the North Vietnamese economy was greater than the gain from supporting the revolution in the South. Or third, that the morale of the North Vietnamese population would so deteriorate that the leadership would be forced to seek relief from the bombing through negotiations or reduced support for the forces in the South.

"Examination of the results of the bombing indicates that none of these suppositions have been borne out in practice." (Biles, 1972, p. 15).

One seeks in vain for evidence from Rhodesia,where real GDP grew at nearly 7% per annum during 1965-74. Only in an opportunity-cost sense could it be said that there was hardship. In any case, it was not sanctions that humbled the white government of Rhodesia. See Porter, 1978a.

I begin with a "basic theory" of sanctions. For ease of exposition, this theory is aggregative, static, and neo-classical.[1] After this "basic theory" is developed, five alternative theories of how sanctions are supposed to work will be briefly examined. To understand the "basic theory," it is sufficient to consider a hypothetical target country that produces and consumes two commodities and initially trades freely at exogenously determined prices.[2] Figure 1 displays the standard trade model, with the (concave) production possibility curve, the (convex) community indifference curve, and the optimizing trade possibility line, tangent to both curves. For maximum welfare (W_0), the country produces x_0 and y_0, exports good x and imports good y, and consumes x_1 and y_1. In Figure 2, a dashed community indifference curve (W_1) is added which shows the highest welfare the country can attain if it is denied access to international trade; it produces and consumes x_2 and y_2; its welfare, W_1 instead of W_0, is clearly reduced.

Examination of Figure 2 indicates that the magnitude of this relative loss of real income will be greater i) the less flat (i.e., more concave) is the production possibility curve, ii) the less flat (i.e., more convex) is the community indifference curve, or iii) the greater is the initial trade. In other words, sanctions which preclude trade will be more effective i) the more inflexible is the target country's production structure, ii) the more inflexible are its consumption preferences, or iii) the greater is its initial dependence on imports and exports.[3] In

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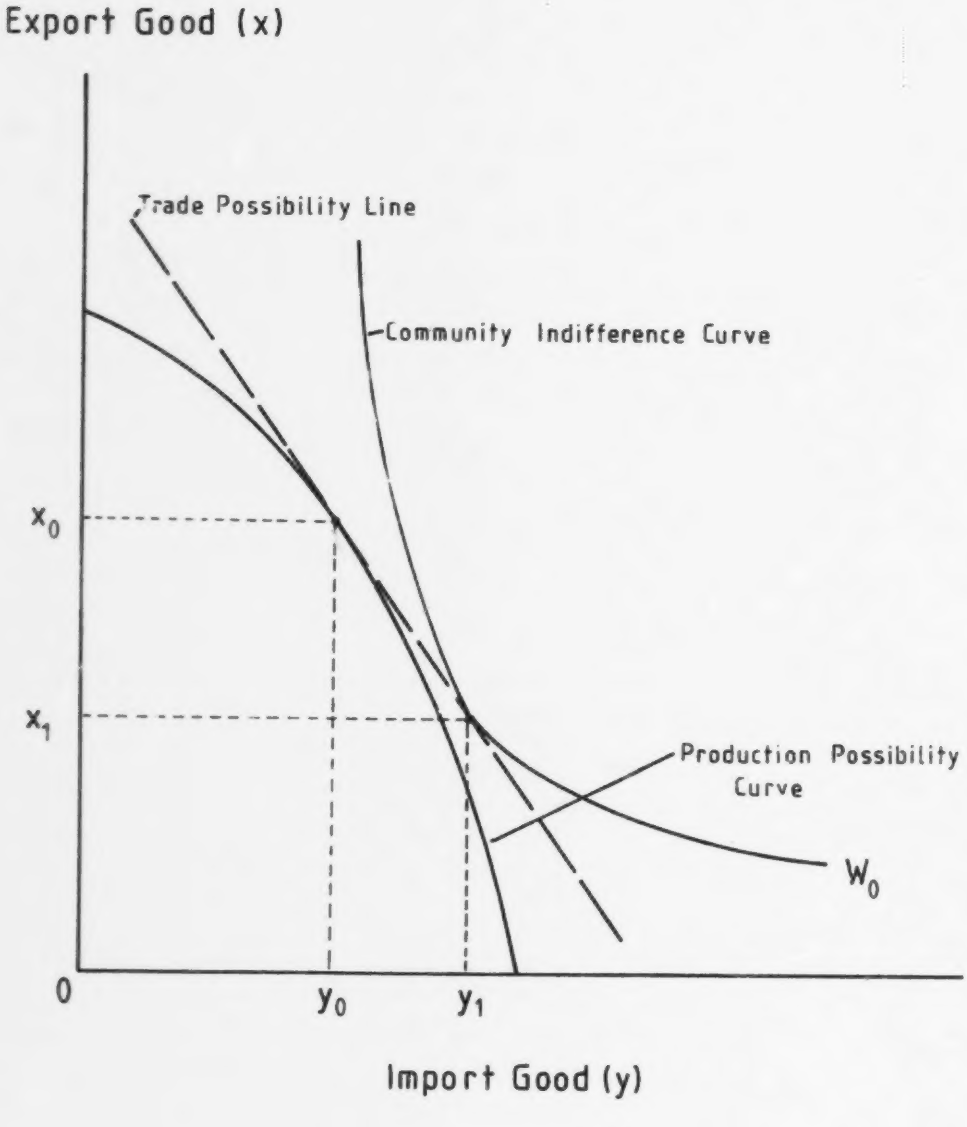
[1] However, the empirical work in Sections IV and V is based on a model that is disaggregated (i.e. the economy contains eight sectors), and fixed-coefficient (i.e. much of the substitutability of neo-classical functions will be discarded in order to make the empirical work feasible). The empirical work there continues to be static, which means that it will be concerned only with the short-run implications of sanctions.

[2] For analytical simplicity, the possibility that factors of production also move is ignored. But we must remember that, for South Africa, labor and capital movements have always been important.

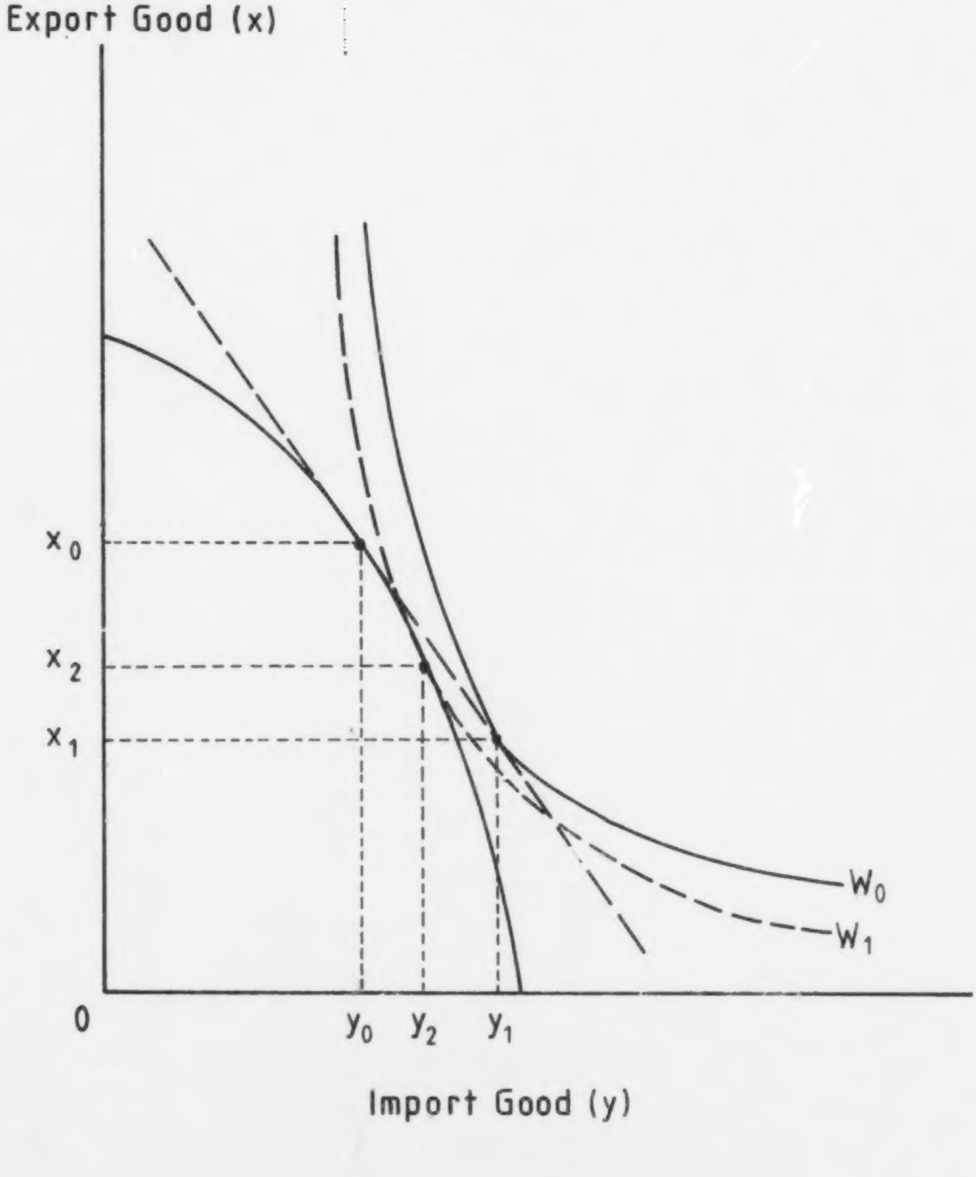
[3] This last condition is the only one that is usually explicitly mentioned in the sanctions literature - see for example Maizels, 1964, pp. 120-121.

FIGURE · 1



Export Good (x)
Trade Possibility Line
Community Indifference Curve
x_0
x_1
Production Possibility Curve
W_0
0
y_0
y_1
Import Good (y)

FIGURE 2


Export Good (x)
x_0
x_2
x_1
0
y_0
y_2
y_1
W_0
W_1
Import Good (y)

light of these three conditions, it is easy to see why great things might be expected by the world community of sanctions against South Africa. Imports equal roughly one-fourth of South Africa's Gross Domestic Product (GDP); its exports are heavily dependent on a few minerals; and it might still be viewed as lacking the economic maturity that lends flexibility to a productive structure.

So far this basic theory has treated the degree of flexibility and dependence of the target country as essentially exogenous data. For the sanctioning countries, of course, this is correct; but an expectant target country can do much to increase its flexibility and reduce its dependence on imports.[1] One can readily envisage incorporation of duopoly-like threats and reactions into the model, but no formal extension is necessary to see its principal lesson: that the longer the world debates the imposition of sanctions, the smaller may be their effect when finally imposed.[2]

The basic theory above is also developed on the assumption that sanctions are universal - that is, they completely prevent all imports into the country. If only some countries impose sanctions, the impact depends critically on the extent to which the target country can acquire the same imports from other sources.[3] Again, a formal model - incorporating limits to the target country's exports and imports - is not needed to see the principal result: partial sanctions achieve, at best, partial results.

While the foregoing analysis and conclusions seem straightforward, there are alternative theories about the connection between sanctions and welfare:

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[1] For the theory, see Arad and Hillman, 1978. Their potential target seeks to balance "the deadweight-loss of not producing according to comparative advantage" against "the benefit [because of learning by doing] of lower future domestic production costs in an embargoed equilibrium" (p. 2).

[2] In South Africa's case, preparation for sanctions has meant not so much a reduction in dependence or an increase in flexibility as a build-up of stockpiles of critical imports, particularly oil. Careful estimates of the size of South Africa's oil inventory suggest one and a half to two years (see Raiford, 1978, p. 57, and Bailey and Rivers, 1978, p. 58).

[3] The potential for sanctions imposed by all countries but only on certain kinds of imports is discussed shortly.

1. Sanctions which apply only to certain exports and/or imports may be effective if there are inflexibilities in particular areas of consumption or (more plausibly) production in the target economy. In the South African context, partial sanctions might be effective if they can i) somehow "clog" the South African economy with inexportable minerals[1] or ii) damage South African production through the scarcity of critical raw materials (particularly petroleum). The clogging possibility can be seen in Figure 2; if the policy-makers of the target country cannot (or dare not) force a reduction in export-good production (from x_0 to x_2) the final welfare position is reduced even below W_1 (as production and consumption of the import good is reduced below y_2 to y_0). Although this happened to some extent in Rhodesia (with tobacco), it seems less likely to arise in South Africa (with gold and diamonds) and will be ignored hereafter. The possibility of bottlenecks due to scarcity of particular imports is more relevant and could be examined through a sufficiently disaggregated model. Unfortunately, our simulations deal with eight sectors, which is hardly disaggregated enough.

2. Sanctions may cause a reduced growth rate. Even if the static real income losses are not large, they represent losses at the critical margin and increasingly will show up as inefficiency in the use of labor and capital, reduced saving (and investment) rates, hence a lower rate of growth of output. By focusing on growth, hence the long run, this alternative suggests the need for patience and persistence in the use of sanctions.[2] This theory conflicts with the basic theory more directly than it at first seems. Static analysis assumes that the elasticity of substitution in both production and consumption increases, the larger the period considered. Thus, for the basic theory, sanctions must work quickly, for they are increasingly averted by long-run adjustment. The empirical

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[1] The envisioned "clogging" is of course not physical but fiscal.

[2] It also assumes that foregone growth, even without an actual decline in living standards, will weaken the target country's resolve.

work in Sections IV and V is based on a simple model that does not consider saving, capacity growth or time, hence cannot examine this alternative to the basic theory, but it is discussed in the next section.

3. According to a more Keynesian view of sanctions, one should focus on the lost exports which represent a decline in aggregate demand and, after the operation of the multiplier, result in recession and unemployment (presumably of whites as well as blacks). This is a very different approach to sanctions. It is entirely demand-focused, whereas the basic theory is entirely supply-focused. Accordingly, the policy implications also differ. In neither view is it necessary to impose sanctions on both sides of the export-import trade. In the basic theory, the critical sanctions are against imports;[1] in the Keynesian model, the critical sanctions are against exports.[2] The difficulty with this Keynesian, aggregate-demand model is that it must be assumed that the target country is unable either to recognize the source of its reduced real income or to undertake the expansionary macroeconomic policies necessary to offset the losses in export demand. Both of these assumptions are dubious in general, and in the South African context especially unwarranted -- with increasing internal and external pressures requiring defense expenditures. Any aggregate-demand impact of economic sanctions is hereafter ignored.

4. According to a dualistic view of the South African economy, there is an "unlimited" supply of black labor available to the modern white-directed industrial and agricultural sectors at a low, constant, and irreducible opportunity cost. Under this assumption, none of the damage imposed by sanctions can be shifted to blacks; and hence even a quite small impact on aggregate variables may be critical to the wages, profits, employment, consumption and welfare of the relatively small white ruling community.[3]

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[1] In terms of Figure 2, if the country continues to export but is unable to import, its consumption bundle will be somewhere within the production possibility curve, and its welfare level therefore even lower than W_1.

[2] Although sanctions against imports will also have some effect to the extent that they lower the marginal propensity to import, and thus raise the multiplier. For examples of this demand-focused approach, see Appendix D.

[3] See Porter, 1978, for a more complete development of the picture of the South African economy which underlies this view of sanctions.

In fact, employed black laborers in the cities of South Africa earn wages well above the standard of living of rural blacks. Their unemployment as a result of sanctions would mean that blacks as well as (or instead of) whites suffered.

5. Finally, there is a view of sanctions that sees their effects as perverse (from the position of the countries imposing the sanctions). This theory begins with the belief that economic development requires a poor country to free itself of dependence on the export of primary products; hence the appropriate development policies include government encouragement of agricultural self-sufficiency and increased protection of industrial production. Thus, economic sanctions may force the target country to adopt the very policies needed for its development. Of course, for best results (from the target country's viewpoint) the sanctions must be partial, effective enough to induce industrialization but not so complete as to make it impossible. Very few writers take this extreme position on the working of economic sanctions,[1] and in any case the argument is much less appropriate for South Africa than it might have been for Rhodesia since the South African economy has already undergone such extensive industrialization and import-substitution. This view is ignored in the empirical effort of Sections IV and V.

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[1] But see, for example, Hoogvelt and Child, 1973.

III. The Dependence of South Africa

"Dependence" has been variously defined and much debated in the literature on economic development. Here, I want to use the word in the senses suggested by the preceding theoretical discussion, namely, the extent to which South Africa is vulnerable as a target for international economic sanctions.

This vulnerability is usually thought to be primarily in the target country's exports, partly because the very word "boycott" has come to mean a concerted refusal to buy rather than to sell, and partly because whatever success was achieved by the sanctions applied against Rhodesia[1] occurred largely through the refusal of the world markets to accept Rhodesian tobacco. The impact of such a reduction in exports follows from the concurrent loss of earnings of foreign exchange and hence the ability to purchase essential or highly desired imported goods.[2]

In South Africa's case, it may be difficult to muster a sufficient world consensus in practice against the purchase of exports as a means of denying South Africa foreign exchange. First of all, nearly half of South Africa's exports are the most eminently acceptable commodity of all: gold.[3] And one half of the remaining exports are readily marketable mineral outputs, raw or slightly processed, which are sufficiently homogeneous to enter world markets with few distinguishable South African markings.[4] It will not be easy for the world to reduce significantly South Africa's foreign exchange availability. An alternative would be world sanctions aimed directly at restricting South African imports. But this also may be difficult to achieve in practice as long as South Africa has the foreign exhcange to pay for imports.

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[1] For a discussion and explanation of the notable lack of success of the Rhodesian sanctions, during 1965-1975, see Porter, 1978a. Total Rhodesian exports were reduced, in 1968, to an annual rate 39% below their 1965 annual rate. (They rose again thereafter.)

[2] Recall that I am ignoring the two possibilities i) that the export loss causes recession through a loss of aggregate demand and ii) that the economy is unable to reduce export production despite its inability to export the resulting output.

[3] Gold exports were R 2,565.3 million in 1974 out of an export total of R 5,571.3 million (excluding re-exports). (The South African rand (R) was worth US $1.40 before 1975 and US $1.15 after.)

[4] These are (in 1974); crude materials excluding fuels (SITC 2), R 594.2 million; non-metallic mineral manufactures (SITC 66), $ 374.3 million; iron and steel (SITC 67), R 217.2 million; and non-ferrous metals (SITC 68), R 290.9 million. The total is R 1,476.6 million, 49% of total non-gold exports.

Whether imports are cut off directly or indirectly through a reduction in South Africa's ability to export and hence its ability to pay for imports, the critical question remains: what damage would the resulting import reductions impose on the South African economy? If one measures dependence on imports as the ratio of imports to output (GDP), South Africa is an average country in this respect, with imports amounting to about one fifth of GDP.[1] Of course, that fraction by itself divulges little because it says nothing of how easily South Africa can dispense with (previously) imported goods entirely or can introduce their production domestically. For this, one must turn to the composition of imports. South African trade data are elaborately reported by both SITC and ISIC (i.e., by source sector),[2] but they are most interestingly viewed by use, as in Table 1.

The industrialization of South Africa over the last half century has not been atypical. As white incomes rose, consumer goods became manufactured domestically, and the intermediate inputs needed also became increasingly produced domestically. Accordingly, the importance of consumer goods and intermediate inputs declined in total imports. Simultaneously, low tariffs on capital equipment, maintained to encourage investment and reduce manufacturing costs, insured that domestic capital goods production lagged, and capital equipment became an ever larger portion of total imports.[3] Indeed, as import-substitution industrialization proceeded into its later, more technologically advanced and capital intensive stages, not only did the dependence on imports of capital equipment intensify, but the ability to produce intermediate inputs domestically failed to keep up. Thus, the decline of

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[1] The countries reported in Kindleberger and Herrick, 1977, range from nearly zero to 76%, with 33 below South Africa and 39 above (p. 284). The median there of imports/GDP is 21%. It should be noted that the Rhodesian ratio was over 30% in 1965.

[2] See also Table B-2 (of Appendix B) for an import classification by sector of source and use.

[3] Zarenda, 1977, calculates that the (weighted average) effective protection of capital equipment was negative in 1956-1957.

TABLE 1

SOUTH AFRICAN IMPORTS, BY USE, 1974[a]

Category of Import	(R millions) 1957	1964	1974
Intermediate Inputs[b]	560.2 (51.0%)[e]	645.5 (42.2%)[e]	2,045.9 (41.7%)[e]
Consumer Goods[c]	231.4 (21.1%)	322.7 (21.1%)	775.5 (15.8%)
Capital Goods[d]	306.4 (27.9%)	556.2 (36.4%)	2,047.4 (41.7%)
Total[f]	1,098.3	1,529.9	4,905.1

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[a] Source: Dept. of Statistics, South African Statistics, various years, table entitled "Imports by Use and Stage of Processing."

[b] Includes "Raw (or crude) materials" and "Processed or manufactured materials" other than "Capital equipment"

[c] I.e. "Articles ready for retail sale or consumers' use."

[d] I.e. "Capital equipment."

[e] Figures in parentheses are percentages of total exports.

[f] Columns do not sum to total because two minor hard-to-classify categories are omitted.

intermediate inputs in total imports decelerated.

Though brief and over-simplified,[1] this account of South African industrialization indicates its point of vulnerability to sanctions. Reduced capacity to import would not have much direct impact on consumer welfare. Less than 10% of total consumption is imported,[2] and much of this is "luxury" consumption, easily expendable in a time of crisis. The brunt of sanctions would be felt in the other two categories of imports, intermediate inputs and capital goods.

For intermediate inputs, analysis at the highly aggregate level at which this section deals yields no insight into the potential effect of sanctions. For that, one must examine the composition of these inputs and estimate the extent to which they can be replaced by domestic production and at what resource cost. A systematic effort to do this is the chief thrust of the next two sections, but only at an eight-sector level of disaggregation.

For capital goods, analysis at the macro level yields a great deal of insight. Imports of capital equipment currently comprise more than one third of total South African gross domestic fixed investment,[3] and the South African construction sector provides 70% of the remainder.[4] Although South Africa has for some time recognized (and worried about) its almost total dependence on capital goods imports, it is still accurate to say that South Africa imports almost all of its capital equipment -- with domestic industry essentially providing only the plant in which it is housed. Thus, if sanctions were to cut off South Africa from capital equipment, South Africa's growth would effectively cease. Indeed, as time went on and depreciation became relevant, the output potential of South Africa would be reduced unless it could rapidly develop from a very undeveloped base its own capital goods industries. No elaborate model is needed to conclude that sanctions against South Africa could be effective in the sense that South Africa's growth as a modern, industrial economy could be dramatically interrupted.[1] Because this conclusion is so obvious, the model developed and applied in the next two sections is only concerned with the short-run impact of sanctions.

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[1] A fuller description is found in Houghton, 1976, Chapters 6 and 8.

[2] See Table B-7.

[3] In 1974, 33.9% (R 2,047.4 million of R 6,026 million). This percentage has remained quite stable over the past two decades: in 1964, 34.7% (R 556.2 million of R 1,605 million); and in 1957, 32.7% (R 306.4 million of R 936 million). (Source for gross domestic fixed investment data: I.M.F., May 1978.) Put differently, imported capital goods made up 79.0% of the total equipment content of fixed investment in 1974 (R 2,047.4 million out of R 2,593 million; source of latter figure: South African Reserve Bank, March 1978, p. S-81); these figures may not be exactly comparable, but they are suggestive.

[4] See Table B-9.

Besides trade, there is a second way in which South Africa is dependent on the world economy: for its net inflow of factors of production. Consider, first, capital. South Africa was a net debtor in the world community in 1976, as Table 2 shows, to the tune of nearly fifteen billion rands, a figure that is roughly half its GDP. Needless to say, few discussions of sanctions against South Africa fail to consider the "disengagement" or "withdrawal" of foreign capital.

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[1] All studies I have seen agree on this. For examples:

> Within a few weeks - if I am right in thinking that the South African authorities would react by rationing and putting the country on a war footing - there would be a marked but not fatal impact on the business community, on agriculture; and on the way of life of everybody. Quickly shortages of all luxury goods and more gradually of certain engineering products would emerge. Unemployment in the Reef, in the Cape Peninsula, and more particularly in Port Elizabeth area would grow. But I think it would probably be about two years before the country was faced with breakdown. (Marvin, 1964, p. 240.)

> ...sanctions, although they might foster economic growth in the short and medium-term, are unlikely to have the same result in the long-run as well. In fact, it is likely that with the continuation of the boycotts, the future economic growth of South Africa will be slower than it would be if free international trade were upheld. Presumably, the degree of labour productivity would drop as a consequence of boycotts, ... (Spandau, 1978, p. 271.)

Note that the two authors do disagree on the short-run impact of sanctions.

TABLE 2

FOREIGN ASSETS AND LIABILITIES OF SOUTH AFRICA, 1976[a,b]

Category	Assets	Liabilities	Net Liabilities
Private Sector			
Short-term	989	2,660	1,671
Long-term			
Direct	1,787	6,342	4,555
Non-Direct	368	6,684	6,316
Government[c]			
Short-term	1,221	2,235	1,014
Long-term	645	2,008	1,363
Total	5,010	19,929	14,919

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[a] At end of year.

[b] Source: South African Reserve Bank, March 1978, pp. S-64 through S-67.

[c] Banks are included under "Government."

[d] Short-term assets includes "Gold reserves" and "SDR's."

The process whereby sanctions on international investment damage the target economy is more subtle than the theory about trade sanctions, and misconceptions abound. To begin with, the very words "disengagement" and "withdrawal" invite misinterpretation. There is no possibility that South Africa would permit the actual withdrawal of the capital equipment which is the physical counterpart of the foreign net asset position in South Africa.[1] Should foreigners attempt to unload the shares, loans, mortgages, etc. that represent claims on South African output, they would threaten disorder in the financial and foreign exchange markets of South Africa, but they would not reduce the economy's real capital stock one iota.[2] The most that "disengagement" can mean, therefore, is the cessation of new (and replacement) investment. It might also mean, in the case of multinational corporations,[3] that the parent would withhold personnel, intermediate inputs, and technological information from its South African subsidiary. With respect to personnel, withdrawal would be marginal, as South Africans now provide almost all the manpower, even at the highest levels, in their industrial establishment. With respect to inputs, the workings of the sanctions follow the path already discussed for imports in general; the amount of damage hinges on the difficulty in South Africa of replacing the foregone imports from other (domestic or foreign) sources, or doing without.

In the end, therefore, withdrawal of international investment is basically a growth-related threat. Except as a form of import sanction, it cannot impose much short-run impact. Through its investment and technological components, however, such disengagement has a large potential impact on South Africa's rate of growth.

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[1] Of course, not all such assets need have a physical counterpart -- one can borrow to consume as well as to invest.

[2] A point carefully made by Harvey, 1975. Of course, the financial disruption might make it difficult for South Africa to operate this capital at capacity. (See Myers et.al., 1978.)

[3] Note that nearly one third of South Africa's international liabilities are comprised of direct, long-term, private sector indebtedness.

A second misconception about investment sanctions stems from a fascination with the ratio in South Africa of foreign investment to total investment: "During the years 1970 to 1977, average annual foreign capital inflows amounted to $580 million or 9.4 percent of gross investments " (Spandau, 1978, p. 197). The implication is that a one dollar reduction in foreign investment will lead to a one dollar reduction in total investment.[1] The implicit macro model is both naive theoretically and refuted empirically. In 1977, for example, the net capital inflow into South Africa fell to minus R 1,096 million from plus R 1,110 million in 1976, a drop of R 2,206 million. Gross domestic investment fell from R 8,608 million to R 8,303 million, only 3.5%.[2] Even lagged relationships are unlikely. In the early 1960s, foreign capital flowed out of South Africa for seven years[3] and real GDP in South Africa continued to grow at five to six percent per annum throughout the period.

The real impact of any reduction in foreign (net) investment in South Africa must derive, in the short run, from its impact on the balance of payments. Inflow of capital permits South Africa to import more, for given exports, and hence achieve a higher level of welfare (if the additional imports are consumer goods), output (if they are raw materials), or growth (if they are capital goods). A reduction in this capital inflow would force South Africa to reduce its imports -- even without trade sanctions being imposed and as a result the economy would suffer the same kind of short-run economic damage as with direct import sanctions.

Capital sanctions would, of course, invite retaliation. South Africa probably would, as Rhodesia did, react to a ban on capital inflows by banning capital outflows and, more critically, the remission of interest, dividends, etc. on foreign assets in South Africa. It is instructive to examine the joint impact on South Africa's balance of payments of world investment sanctions and such a South African retaliation. In Table 3, the South African balance of payments for 1972-76 is shown.[1] In parentheses are shown what the figures would have been in each year if i) world investment sanctions had cut off all long-term capital movements into and out of South Africa, ii) South Africa had prevented all investment income, non-trade-related service payments, and transfers from moving into or out of South Africa, and iii) trade had (somehow) not been affected by either of these events.[2] It can be seen in Table 3 that the net effect of these changes would have worsened South Africa's "basic balance" in only three of the last five years. Indeed, if South Africa had altered its imports each year so as to have maintained the same basic balance with investment sanctions as it would have had without, its total imports for the five-year period would have had to contract by less than 3 percent. If short-term financing had also become unavailable, and South Africa had had to alter its imports each year so as to have maintained a zero basic balance under investment sanctions, its total imports for the five-year period would have had to contract by less than four percent.

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[1] Or perhaps even a multiplied reduction of US $10.64 (equals $1/.094) in total investment!

[2] Source: South African Reserve Bank, March 1978, p. S-81.

[3] The net outflow was R 485 million over 1959-1965 (Harvey, 1975, p. 21).

In sum, investment sanctions show much less potential than trade sanctions for causing a reduction in South African imports. Total capital sanctions might reduce imports by only a few percent. In the model of the next two sections, we will make different assumptions about what happens to South African foreign capital flows (i.e., to the balance of trade) under sanctions; as might be anticipated from the above discussion, the results in the short-run, which is all the model considers, are not very sensitive to this choice of assumption.

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[1] 1977 is not yet available.

[2] Travel is also assumed unaffected. The reason for excluding trade effects is not (obviously) to write a realistic scenario but rather to isolate the potential balance-of-payments impact of investment sanctions alone. In reality, of course, many of the capital flows are simply the financial counterpart of a trade flow.

TABLE 3

SOUTH AFRICA'S BALANCE OF PAYMENTS, 1972-1976, WITH AND WITHOUT INVESTMENT SANCTIONS[a], [b]

(in R millions)

Category	1972		1973		1974		1975		1976	
Exports (including gold)	3,377		4,287		5,729		6,193		7,235	
Imports	-2,840		-3,550		-5,768		-6,742		-7,443	
Balance of Trade		+537		+737		- 39		- 549		- 208
Services Receipts [c]	762(348)		962(414)		1,114(537)		1,400(662)		1,505(684)	
Services Payments [c]	-1,436(-530)		-1,765(-632)		-2,157(-894)		-2,802(-1,045)		-3,023(-1,028)	
Transfers (net)[d]	47(0)		14(0)		84(0)		138(0)		96(0)	
Balance on Current Account		- 90(+355)		- 52(+519)		-998(-396)		-1,813(-932)		-1,630(-552
Long-Term Capital Movement (net)	628(0)		214(0)		761(0)		1,746(0)		989(0)	
Basic Balance		+538(+355)		+162(+519)		-237(-396)		- 67(-932)		- 641(-552

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[a] Data source: South African Reserve Bank, March 1978, pp. S-57, S-60.

[b] Figures not in parentheses are the actual (i.e., without sanctions) data; those in parentheses are the hypothetical (i.e., with sanctions) data.

[c] "Services" includes "investment income," "non-merchandise insurance" and "earnings and expenditures by foreign workers, communications, advertising, rentals, royalties, etc."

[d] "Transfers" includes "migrants' funds, legacies, grants, etc."

A second factor of production also migrates, in a net sense, into South Africa: labor. The "modern" part of the South African economy receives (net) [illegible]te and black labor through migration. International sanctions could attempt to reduce either or both of these flows. The magnitudes are not trivial. South Africa's white population currently has a natural rate of increase (i.e. birth rate minus death rate) of 1.2 percent. Net immigration of whites has, over the past decade, been around 30,000 per annum, which has raised the growth rate of the white population by about one percentage point. White immigration supports the white polity and economy in a number of well-known ways. The availability of black labor from neighboring countries helps to insure an unlimited supply of low-opportunity-cost labor.[1] However, since sanctions along these lines are rarely discussed, I shall ignore them in the work of the next two sections.

In summary, there are two basic kinds of sanctions, trade sanctions and capital sanctions, and two general kinds of impact, in the short run and on growth. South Africa's extreme dependence on imported capital goods makes it very probable that its growth would be critically affected by a reduction in its ability to import. And investment sanctions which reduced its access to new technology would also hurt its growth potential. The impact of sanctions in the short run, however, is much less clear. Sanctions which cut off capital inflows into South Africa would almost surely be met by retaliatory bans on outflows, and the overall short-run effect on imports and output would probably be small. Sanctions which directly reduced imports would certainly directly affect South Africa's output, but by how much is an empirical issue which hinges essentially on the flexibility and adaptability of the South African industrial structure. The model developed and exercised in the next two sections is intended to provide some insight into this flexibility, [illegible] hence some idea about how much South African output would be reduced by imposed reduction in its imports.

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[1] See Porter, 1978.

IV. A Model to Estimate the Impact of Sanctions

In this section, a model is developed to estimate the short-run effects on the South African economy of various trade and investment sanctions that could be imposed. The model is static, in the sense that the initial capital stock is taken as given throughout, in total and by sector, so that the estimated effects of sanctions can be thought of as those occurring in the short run -- a period long enough that initial stockpiles become irrelevant but short enough that compensatory growth and shifts (and depreciation) of capital are not yet critical. The model is consistent, in the sense that the total supplies from all sources of each output and input must be adequate to provide the total demands for all uses. And the model relies on input-output relationships -- for the output of each of the eight sectors considered, there are needs for inputs of seven kinds of labor, intermediate-good imports, intermediate goods from each of the eight domestic sectors, and plant capacity.

Two ingredients of the [illegible]l which critically underlie the estimates of the impact of sanctions [illegible]ulated in the next section) require discussion before turning to the details of the model. First, it is assumed that the South Africans react *optimally* to sanctions; that is, they maximize a social objective function,[1] subject to the constraints imposed upon them by sanctions. This means that the model specifically ignores those theories of sanctions that work through reduced aggregate demand or target-country policy failure or inertia. In this sense, therefore, the resulting estimates are of the *minimum* impact of sanctions. South African policy ineptness, confusion, or inadequacy could immeasurably compound this impact.

And second, it is assumed that there is some *substitutability* in South African production functions. If there were none, then except as unnecessary final-demand imports could be curtailed, any reduction in imports would mean reductions in intermediate good imports; this, in turn, would cause a proportionate reduction in the output of the sector for which they were destined and unemployment of a proportionate amount of labor and capital there. Such an assumption would be extreme, as examination both of South Africa's specific imports at the detailed microeconomic level and of the evidence from Rhodesia in the late 1960s shows.[1] But the other extreme, to assume that South African labor and capital could readily produce a replacement for any import, is equally untenable. We shall assume that, even in the short run before new capital can be installed, South African labor can replace imports to some extent but at a high cost.

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[1] Its components will be discussed later.

That is a broad outline of the ingredients of the model. The rest of this section explains the model in greater detail, but still entirely in words. (The equations of the full model are described in Appendix A; the data base and the parameter estimates are shown in Appendix B; and the precise nature of the substitutability between labor and imports is developed in Appendix C.)

The discussion below is first of the constraints on South Africa's economic activity, and then of the objective function of South African policy-makers. There are three kinds of constraints: i) technological constraints; ii) external constraints imposed through international sanctions on imports into South Africa; and iii) constraints which South Africans choose to impose upon themselves. This third group of constraints perhaps needs a few words of general explanation, as it appears inconsistent to try to maximize an objective function and simultaneously to restrict one's actions in that effort. Some of these constraints are historically, culturally, or behaviorally sufficiently entrenched as to be either unrecognizeable to South African policy-makers as potential policy tools or not susceptible to change even under conditions of crisis. Others of these constraints are really part of the objective function, but the extremely non-linear way in which they enter makes it more convenient to consider them as policy constraints.

The technological constraints involve the relationship between the various inputs and each sector's output. For the most part, it is assumed that there is no substitutability between inputs, hence that there is a certain amount of each input required per unit of each sector's output.

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[1] Rhodesia's real GDP fell only in 1966, by 4.4%, while its imports fell by 29.4%. Real GDP began to rise again in 1967, even though imports did not regain their 1965 level until 1971. See Table 1 of Porter (1978a).

Thus, for each of the seven occupations and eight sectors, there are labor-output coefficients (56); there are also interindustry intermediate-good input-output coefficients (64, though many are zero); there are intermediate-good import-output coefficients (8); and there are capital-output coefficients (since capital is unchanging and sector-specific in the short run, these coefficients enter simply through a maximum output level for each sector). The one kind of substitution between inputs which can occur in the model is that labor can replace intermediate-good imports. In terms of Figure 3, if output under sanctions were to require labor and imports in the same ratios as before sanctions, the unit-output isoquant would be the solid right-angled line, $\alpha\beta\gamma$. In the model, we shall assume instead that such imports can be economized if sufficient new labor is employed; hence a range, $\beta\delta$, in which substitution can occur. The unit isoquant employed in the model is therefore the partly solid and partly dashed line, $\alpha\beta\delta\varepsilon$.[1]

Labor in the model is disaggregated into occupations (seven), races (two[2]) as well as sectors (eight). It would be clearly unrealistic to assume that, even in the short run, there is a fixed labor-output coefficient for each kind of labor and for each race. But introducing substitutability -- with less than an infinite elasticity of substitution -- is difficult in a linear programming model. The very system of South African discrimination suggests the solution. Within any broad occupational category such as we are using -- e.g., production or sales worker -- blacks there will be trained to do only the lower-rung jobs and hence would be able to substitute for the better educated, better trained, higher-rung whites to only a limited extent, namely around the ladder-rungs at which the races are divided. Thus, within any occupation, whites and non-whites are assumed perfectly substitutable as long as the ratio between the two races remains within a

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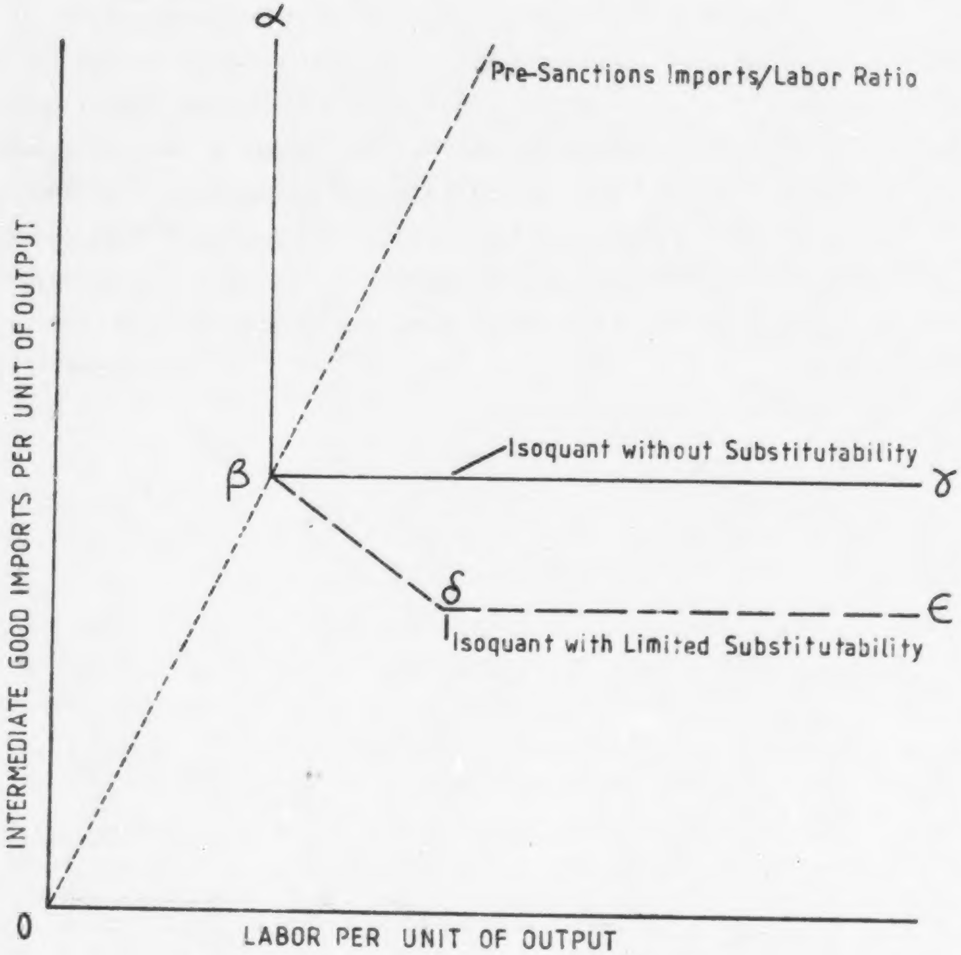
[1] This means, of course, that the implicit production possibility curve of Figures 1 and 2 is not a smoothly curved function.

[2] White and non-white. At the level of aggregation of sectors and occupations, it seemed overly ambitious to attempt to treat "coloureds" and "Asians" separately.

FIGURE 3


α
Pre-Sanctions Imports/Labor Ratio
Isoquant without Substitutability
β
γ
δ
ϵ
Isoquant with Limited Substitutability
INTERMEDIATE GOOD IMPORTS PER UNIT OF OUTPUT
0
LABOR PER UNIT OF OUTPUT

certain percentage of the pre-sanctions ratio; beyond that percentage, no further substitution is possible.[1] Because the occupational groups are so broad, it seems reasonable to assume that there is no substitutability between labor of different occupations. Finally, a constraint was also included concerning the total number of workers in the more skilled occupations; this is intended to reflect the fact that, in the short run, the amount of labor upgrading and training that can be completed is quite limited.

The possible constraints imposed on South Africa through international sanctions have been extensively discussed in the previous two sections. Here it need only be recalled that their common denominator is the withholding of crucial imports. The model treats this not as a direct curtailment of imports but rather as a reduction in exports and/or foreign capital flows, which in turn means a reduction in foreign exchange earnings by South Africa , hence its ability to pay for imports. In the next section, the extent to which exports and the balance of trade are affected by sanctions will be varied among simulations, but the effect is always to reduce imports , hence the ability of the South African economy to produce output. The sanctions this model considers are always reductions in imports, but South Africa is always left free to determine the composition of these imports. Direct restrictions on the composition of imports would further hurt South African GDP.

Although is it difficult to forecast how policy-makers will react to a crisis of a nature and extent not previously observed, there are clearly constraints on what South African policy can do. We assume relatively few constraints; if there are more, and they are binding, then the GDP estimates of this model are biased upward (that is, the harm done by sanctions would in fact be greater than here estimated). The policy constraints in the model:

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[1] Of course, in the long run, even in South Africa, workers of the same occupation but different races are potentially substitutable to any extent. But we here are concerned with the short run within a system of continuing, institutionalized racism.

1. The long run must not be sacrificed, thus the total and sectoral composition of investment is to be maintained (if possible).

2. The need for government activity is not reduced because of the crisis, thus total government consumption is to be maintained (if possible) and its sectoral composition varied only within narrow limits.

3. The sectoral composition of private consumption can only be varied, in the short run, within narrow limits.[1]

4. Full employment of the white labor force is to be achieved (if possible).

5. White laborers are not to be "uprooted" (if possible), so the total number of white workers in each occupation-and-sector is subject to change only within narrow limits.[2]

The objective of South African policy-makers, once faced with sanctions, is assumed to be simply the maximization of total output, or GDP. Other objectives were considered -- such as the maximization of total white (wage plus nonwage) income or consumption -- but, given the model and its constraints, this seemingly important change did not much affect the results of the simulations.

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[1] This means, of course, that the implicit community indifference curve of Figures 1 and 2 is not a smoothly curved function.

[2] The parenthetical "if possible" (in each of the constraints except #3) indicates that the constraint will be relaxed if no solution is feasible when the constraint is included. (The precise way in which they are relaxed is described in Appendix A.) That these constraints have been relaxed is signaled in the next section by reference to a "less exacting set of policy constraints."

V. Estimates of the Impact of Sanctions

This section, which estimates the impact of sanctions (according to the model described in the previous section), is divided into four parts. First, a baseline picture is established of a South African economy that is prepared for, but not yet actually subject to, sanctions. Second, the economy is simulated, through the model, as if it were subject to sanctions which reduced its exports and capital inflows by various across-the-board percentages. Third, the sensitivity of the results to changes in parameter values and assumptions is explored. And finally, a "greatest impact" of sanctions is estimated by moving simultaneously all parameter values and assumptions to their most damaging but still plausible extremes.

A baseline picture of the South African economy without sanctions must be drawn in order to estimate the impact of sanctions. Although the actual official South African statistics of some recent year would seem to provide an adequate base, there are two problems. First, the data needs of the model are sufficiently great that the year 1967 had to be chosen as the base.[1] Moreover, since data from different official sources had to be molded into one internally consistent set, the base-year "1967" that emerged is not exactly the same, in most of its statistical components, as any official South African "1967." The adjustments are more fully explained in Appendix B.

The second difficulty with using actual data as a basis for comparison is that South Africa has never urgently anticipated the imposition of sanctions. Thus, the proper comparison, for estimates of the impact of sanctions, is between South Africa under sanctions and a South Africa prepared for, but not actually suffering from, sanctions. The very preparation process, which would presumably achieve a fuller utilization of existing supplies of capital and labor, might itself raise South Africa's GDP. Accordingly, the base year itself requires simulation. This picture of South Africa before sanctions but prepared for sanctions is created by running the model with exports and the balance-of-trade deficit only constrained to be no greater than their actual 1967 levels.

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[1] Real GDP rose by about one half between 1967 and 1977.

The "actual" data of 1967, adjusted as described in Appendix B, and the hypothetical model-generated 1967 data of a South Africa prepared for sanctions are compared in Table 4.[1] The model indicates that two notable changes occur in this process of becoming prepared. First, exports and imports are reduced about six percent. This seems curious in that sanctions have not yet been imposed, but what it actually reflects is a large reduction in luxury consumption imports and a simultaneous reduction in the need to export to pay for them -- and hence a release of export-labor for production in domestic activities. And second, GDP is expanded by three percent, chiefly by the use of more non-white labor.[2] The figures in the "prepared" column of Table 4 are the base-year data to which all subsequent simulations are compared.

There are an infinite variety of trade sanctions that could be applied to South Africa -- different combinations of sanctioning countries, different combinations of prohibited exports (to South Africa), and different degrees of success in applying those sanctions. The model is too aggregated to explore this variety fully. Here, we will look primarily at across-the-board sanctions; meaning that the maximum value of each sector's exports[3] and the net capital flow (i.e., the trade balance) is reduced, through sanctions, by some percentage. The simulations consider these cuts in 10 -percent jumps, from 10% through 60%. Such across-the-board, but less than 100%, sanctions can be interpreted as a less than complete world involvement in the sanctions and/or a less than complete success at implementing universal sanctions. The simulations cease at 60% across-the-board reductions simply because I felt that by then, the basic structure of the South African economy would surely have become so changed that the model would no longer describe it.

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[1] The fact that the two differ indicates either the extent to which the model is inaccurate or that the economic objectives of South Africa, when not sanctioned, involve other variables than GDP. I am assuming it is largely the latter. Indeed, the larger GDP with "preparedness" may well require policy actions that are dysfunctional for the economy under normal circumstances (a point suggested in correspondence by Desaix Myers).

[2] Recall, white labor is assumed to be already at maximum employment.

[3] Actually, only six of the eight sectors export; see Table B-1 of Appendix B.

TABLE 4

THE ACTUAL AND PREPARED SOUTH AFRICAN ECONOMY, 1967

(R millions)

Statistic		South African "Data," 1967		
		Actual	"Prepared"[a]	Percentage Difference[b]
Value Added in				
Agriculture	(1)	941	1,009	+7.2%
Mining	(2)	953	963	+1.0
Manufact'g	(3)	1,507	1,632	+8.3
Construction	(4)	413	414	+0.2
Electricity	(5)	228	247	+8.3
Trade	(6)	632	653	+3.3
Transport	(7)	1,228	1,150	-6.4
Services	(8)	2,253	2,332	+3.5
Total (GDP)		8,156	8,400	+3.0
Exports	(E)	2,547	2,396	-5.9
Imports	(M)	2,440	2,289	-6.2
Deficit	(D)	-107	-107	--[c]
Wage Income				
of Whites		2,740	2,747	+0.3
of Non-Whites		1,193	1,272	+6.6
Non-Wage Income		4,223	4,382	+3.8
Employment[d]				
White		1,190	1,190	--[c]
Non-White		5,179	5,510	+6.4

[a] See text for description of this term.

[b] Prepared minus Actual, divided by Actual.

[c] Constrained to zero; any difference is due to rounding error.

[d] Thousands of workers.

The simulated results of these across-the-board percentage cuts are shown in Figure 4. The data for the zero "cut" represent the "prepared" but not yet sanctioned economy described earlier. 10% and 20% reductions have relatively small impacts on GDP and its components.[1] The implied elasticity of GDP with respect to sanctions is less than one-half -- that is, for small reductions, an x% across-the-board cut in exports and the trade balance causes a less than 1/2 x% cut in GDP.

The impact increases significantly once 30% cuts are considered. GDP drops to R 6,575 million, 21.7% below the prepared but not yet sanctioned level of R 8,400 million. The cause of this increased impact is not hard to find. Initially, imports of finished consumption goods comprise 17.8% of total imports. When sanctions are applied, luxury consumption imports are foregone (by South Africa) first. These provide a cushion of expendable imports that prevent "light" sanctions from having much impact on real output. But, by the time 30% cuts are reached, consumption-good imports have fallen to only 8.5% of total imports, and the remaining consumption goods are not so readily given up. At somewhere between 20% and 30% effectiveness, sanctions begin to "bite."

At 40% across-the-board sanctions, there is no feasible solution to the model. By then, sanctions have become sufficiently constricting to the South African economy that all the technological, behavioral and policy constraints of the model cannot be simultaneously satisfied. The South African reaction must be to relax some of the policy constraints. Specifically, I assume that in this circumstance: i) investment can no longer be held at its pre-sanctions level but is only required to be at its pre-sanctions ratio to consumption; ii) ditto for government expenditures; and iii) the "uprooting" of white laborers (i.e., their transfer to other occupations and/or sectors) will be permitted to whatever extent necessary.[2]

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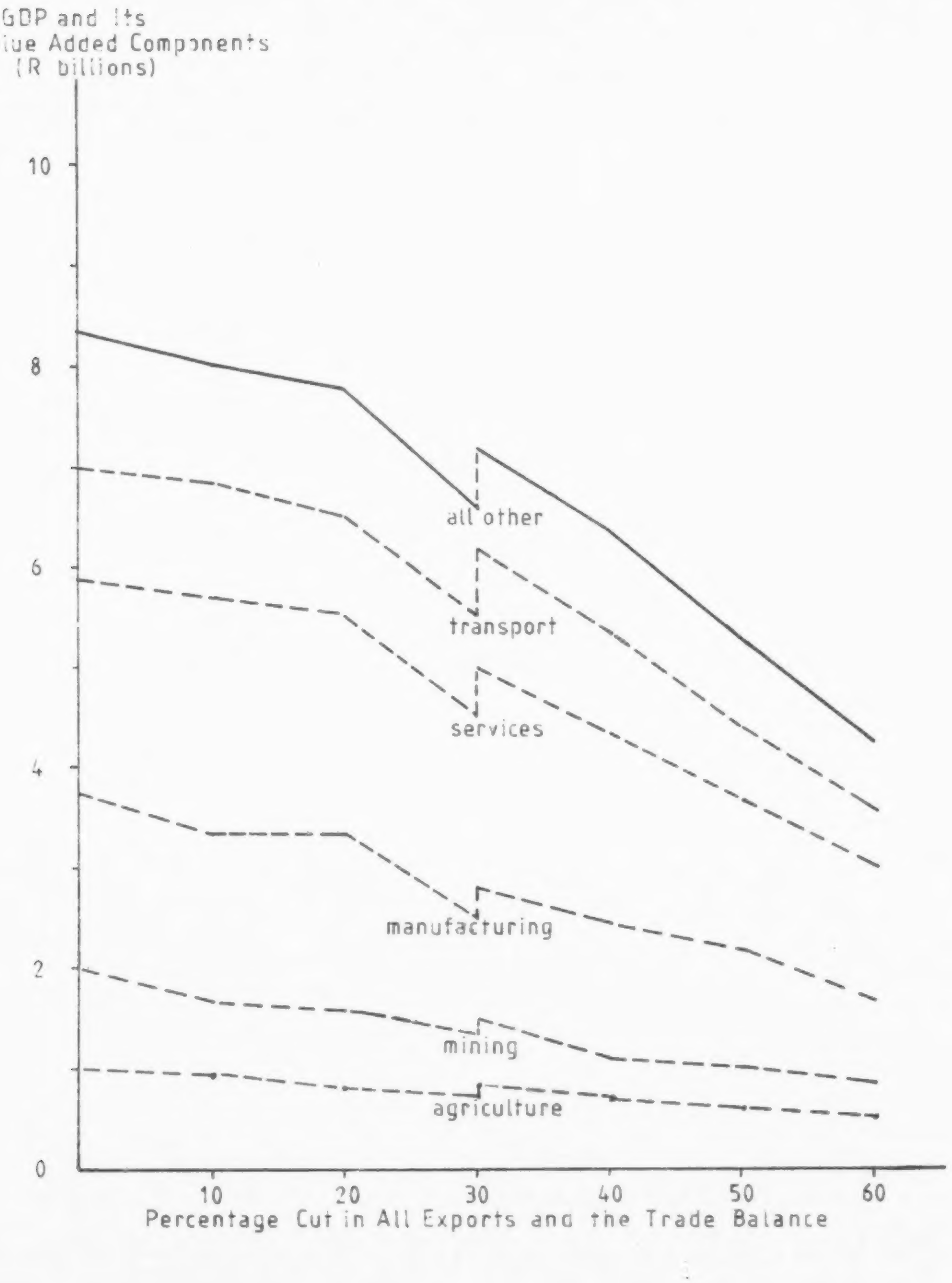
[1] GDP declines from R 8,400 million to R 8,036 million and R 7,811 million, respectively.

[2] Subject still, of course, to a technological constraint on the rate at which new labor can be trained in the skilled occupations. The white full-employment constraint is also relaxed, but white employment is then included in the objective function. (For detailed description of these changes, see Appendix A.)

FIGURE 4 Impact of Across-the-Board Trade Reductions



This less exacting set of policy constraints permits the South Africans to find a feasible solution under sanctions-imposed export cuts of 40% or more.

With the less exacting set of policy constraints, a 30% across-the-board cut in all exports and the trade balance reduces GDP to R 7,002 million. (This is shown, in Figure 4, as the higher of the set of points above 30%.) The implied elasticity of GDP with respect to sanctions remains less than one half. But the achievement of this feasible solution is not without cost. Investment drops to R 2,082 million, only 86.0% of its pre-sanctions level. Similarly, government expenditures are reduced to R 820 million, also (perforce) 86.0% of their pre-sanctions level. There is, moreover, some "uprooting" of white labor, particularly in two sectors (and in one of which, mining, white labor has historically proven the most troublesome in South Africa). In the process of achieving the feasible solution at 30% export cuts, there are 18 thousand white workers laid off in mining, a reduction of 31.0%, and 19 thousand white workers withdrawn from the trade sector, a reduction of 15.8%. Particularly in mining, this may represent a politically intolerable shift in the structure of white employment.

Once the adjustment is made to the less exacting set of policy constraints, further across-the-board reductions in exports and the trade balance as a result of sanctions cause quantitatively even more severe, but qualitatively similar, output reductions. As 40%, 50%, and 60% sanctions are simulated, South Africa's GDP drops to 74.5%, 62.3% and 50.3%, respectively, of its pre-sanctions (but "prepared") level. Clearly, sanctions at these levels can cause significant damage to South African GDP. The damage is not only in the loss of output. With 60% sanctions, 10.3% of the white labor force becomes unemployed (and non-white employment has fallen from 5,510 thousand in the pre-sanctions situation to 4,530 thousand, i.e., by 17.8%). And the uprooting of whites in certain sectors has become an immense problem; for example, 37.4% of the white construction workers and 30.6% of the white manufacturing workers must be laid off (or reallocated to other sectors).

There are two other basic variations of sanctions that were examined. First, we have so far estimated the impact of sanctions which had "across-the-board" effects on exports -- that is, which reduced the exports of all sectors by the same percentage; but South Africa's mining sector exports appear much less vulnerable to sanctions than are its other exports. Let us consider the extreme case where sanctions are completely effective against the exports of all sectors other than mining but are completely ineffective against the exports of the mining sector. This means a 100% reduction in the non-mining 55% of South Africa's total exports,[1] and the results of this simulation of unbalanced sanctions can be meaningfully compared to across-the-board sanctions which achieve 50% or 60% reductions in each sector's exports.[2] In fact, the aggregate statistics of the mining-exports-only simulation compare quite closely to the 50% across-the-board sanctions, as Table 5 shows. GDP and consumption are only slightly lower. And white full employment continues to be achieved in the mining-exports-only situation, as it had in the 50% but not in the 60% across-the-board case. The difference between the two lies, as one might guess, in the mining sector. In the mining-exports-only simulation, value added and employment in mining are 80.4% and 225.0% higher, respectively, than in the 50% across-the-board simulation. In the 50% across-the-board case, nearly half the white (and non-white) mining workers must be laid off; while in the mining-exports-only case, the white (and non-white) mining work force must be almost doubled -- somehow -- from its pre-sanctions level.

The second variation examines the impact, ceteris paribus, of sanctions that affect the net capital flow differently from the trade flow. In the across-the-board simulations, each sector's exports and the balance of trade were all varied by the same percentage. Now, we consider a situation in which each sector's exports decline by some percentage but the balance of trade does not change. Since the balance of trade was positive in the

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[1] It is also assumed in this run that trade is balanced, i.e., that sanctions effectively stop all capital flows that might permit trade imbalance.

[2] All runs are made with the less exacting set of policy constraints.

TABLE 5

COMPARISON OF ACROSS-THE-BOARD AND MINING-EXPORTS-ONLY SANCTIONS

(R millions and thousands of workers)

		Across-the-Board Cuts of		
Statistic	Prepared But Not Yet Sanctioned	50%	60%	Mining Exports Only
Value Added in				
Mining (2)	963	491	398	886
Total (GDP)	8,400	5,234	4,224	5,130
Consumption (C)	4,918	3,072	2,479	3,042
Employment in				
Mining (2)[a]	594	336	491	1,092
Total White	1,190	1,190	1,068	1,190
Total Non-White	5,510	5,461	4,530	5,388

[a] Production workers only (i.e., $L_{162} + L_{262}$).

base year, this is equivalent to assuming that net capital movements into South Africa were reduced by a larger percentage than were exports, thus that imports must also be reduced by a larger percentage. In the simulation actually undertaken, exports were reduced, across-the-board, by 30% and the balance of trade kept at its initial level. This meant that imports had to be reduced by (at least) 31.31%. In order to see the difference between the effect of import cuts caused by trade sanctions and those caused by capital flow sanctions, we will compare these results with an across-the-board export and trade surplus reduction of exactly 31.31%. Imports are reduced identically in the two cases, but the export total is reduced 30% in one case and 31.31% in the other.[1] The difference, as one would hypothesize from the discussion in Section III, is slight. GDP differs by only 0.3% in the two cases.

Before conducting sensitivity tests, we should notice exactly where in the South African economy the critical pressure of sanctions is felt -- or more precisely, in the terms of the linear-programming model and its optimization, which of the constraints are most binding[2] at the optimal solution. Rather than report on all the simulations, I will examine two in detail, the 30% and the 60% across-the-board export and trade balance reductions, both under the less exacting set of policy constraints.

At 30% sanctions, many of the foreign trade, import-substitution and labor constraints are already seriously binding. If sanctions could be evaded to the extent that R 1,000 of additional exports could be made, hence R 1,000 of additional imports be acquired, the South Africans could raise their GDP by from R 3,419 to R 3,978, depending upon which sector did the exporting. If R 1,000 of additional capital inflow could be induced, South Africa could add R 3,135 to its GDP. Thus, on the margin (of 30% effective sanctions), each R 1,000 cut in South Africa's exports or capital inflow imposes a loss of output of R 3,000-4,000. Given the costliness of the export losses, the South African economy turns to intensive efforts at import substitution, But there are limits to this process in the short run, and these limits are reached in two sectors, manufacturing and electricity. Furthermore, the ability to reduce final-goods imports, as a percentage of total deliveries, is exhausted for both private and public consumption. The limits of import substitution are not reached in the other sectors because of a scarcity of skilled white labor: an additional white laborer would permit sufficient new hiring of non-whites, labor reallocation and extra import substitution to be worth R 550 in added GDP.[1] Thus, at 30% effective sanctions, any sanctions-induced net white emigration would add somewhat to the economic damage.

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[1] The composition of exports by sector is the same in both cases.

[2] By "most" binding, I mean binding in costly fashion, this being indicated by the shadow price of the constraint.

At 60% sanctions, several more constraints have become binding. A marginal gain of R 1,000 of exports would mean a GDP gain of from R 4,871 to R 5,656, depending on the sector from which the export is made; and a marginal R 1,000 of capital inflow would be worth R 4,503 in GDP. At 60% sanctions, the limits to import substitution have been reached in almost every sector.[2] Scarcity of white labor no longer provides any constraint; to the contrary, white unemployment has become serious.[3]

Sensitivity tests were performed on the model by moving, individually and in combinations up and down by 40% of their basic values, many of the parameters of the model, especially those whose values were based more on intuition than evidence. In none of these tests was the solution value of GDP moved by as much as one percent, except when the parameters representing the maximum limits to import substitution by sector[4] were altered. Let us look at the solution when these limits are all contracted by 40%.[5] With sanctions that effect across-the-board 40% cuts in exports and the trade balance and with the basic parameter values, South African GDP would be cut from $ 8,400 millions (i.e. the pre-sanctions but prepared level) to R 6,260 millions -- that is, by 25.5%. If the simulation is re-run reducing the parameters limiting the scope for import substitution by 40%, the GDP drops still further, to $ 5,730 millions, that is, by another 6.3 percentage points.

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[1] While this figure seems low (see Table B-4), it must be remembered that this marginal white is employed in costly import substitution.

[2] The limit is not quite reached in construction.

[3] The unemployment could only be avoided by downgrading whites to low-rung jobs normally done by non-whites.

[4] I.e. the values of the eight h_j's (see Appendices A and B).

[5] I.e. each h_j is reduced by 40% of its basic value (see Appendices A and B).

In a way, the sensitivity tests tell us what we could well have guessed; namely, that one's estimate of the short-run impact of sanctions on South Africa depends importantly on the estimate of the limits to short-run South African import substitution. But there is a more interesting interpretation of these results. The estimates of the impact of sanctions are not so sensitive as we might have expected to the estimates of the limits to import substitution. In each of the sectors, a careful, plausible guess was made as to these limits. Now these limits are arbitrarily cut by 40% of that guess. And the resulting estimates of the impact of 40% effective sanctions changed by only a few percentage points - i.e. from a 25.5% cut in GDP (from the pre-sanctions level) to a 31.8% cut.[1] In short, the sensitivity tests greatly raise our confidence that the estimates produced by the model are in the right "ball park" and are not highly sensitive to the largely intuited ingredients.

One final sensitivity test was performed, whereby all the arbitrary parameters were simultaneously moved to values 40% from their basic values in the direction which increased the damage to South African output owing to sanctions. Specifically, this "greatest impact" simulation assumed the following:[2]

1. The South African objective function places heavy weight on white employment, to the point where R 2,000 of output (GDP) will be given up in order to employ one more white worker.

2. Sanctions cut all exports and the trade balance to zero, except for mining exports, which continue undiminished.[3]

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[1] In other words, the estimates of impact moved by 25% (31.8 minus 25.5, divided by 25.5) in response to a 40% change in the critical set of parameters.

[2] See Appendix B for the exact description.

[3] Thus, maximum total exports are reduced by 54.8% and imports must be reduced by at least 52.8%.

3. Import substitution is made still more costly,[1] and its limit reduced by 40%, in all sectors.

4. The initial excess capacity in each sector is reduced by 40%.

5. The maximum number of new members that can be trained for the skilled occupations in the short run is lowered by 40%.

6. The extent to which blacks and whites are substitutable for each other, in any given occupation-and-sector, is narrowed by 40%.

7. The degree of flexibility in the sectoral composition of public and private consumption is reduced by 40%.[2]

This "greatest impact" simulation should be compared to the "mining exports only" simulation (see Table 5) since both incorporate the same export assumption. Worsening all the arbitrary parameters at once lowers the estimated GDP from R 5,130 million to R 4,591 million, an additional 6.4% (of the prepared but not yet sanctioned level of R 8,400). Thus, the output estimates are not too sensitive to this extensive parameter variation.[3] Employment estimates, however, tell a different story. Whereas white full employment had been achieved in the mining-exports-only simulation, this greatest-impact simulation displays an 11.8% white unemployment rate (and a reduction also in non-white employment of 14.7%). Thus, the employment estimates generated by the model are fairly sensitive to parameter variation.

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[1] Intermediate inputs as well as labor are required to replace imports (see the "D" simulation of Appendix D, and especially equation (D-12)).

[2] Also, the less exacting set of policy constraints is introduced since, without them, no solution is feasible.

[3] The reduction in the limits to import substitution alone reduced GDP by 6.3%, so all the other changes make practically no difference.

VI. Conclusions and Caveats

Estimates of the impact of sanctions on South Africa depend critically on the kinds of sanctions one envisages, the extent to which they are imposed and enforced, and whether one thinks of the short run or the long run.

Although the analysis in this paper of the long run is brief, it seems clear that sanctions could seriously damage South Africa's growth rates. Cut off from access to new foreign technology and imported capital goods,[1] South Africa could not continue to grow at anything like its historical rates,[2] and perhaps not at all.

The short-run impact of sanctions depends critically on the extent to which imports into South Africa are reduced. Capital, or investment, sanctions would probably not much affect such imports -- especially after the expected South African retaliation cut off capital outflow -- and hence in themselves would not much affect South African production.

Direct restriction of South Africa's ability to import could have a serious impact, in the short run as well as the long run, on South Africa. How much impact would depend on the effectiveness of the embargo. If South Africa's imports were reduced by less than one-fourth, little economic damage would be inflicted - each one percentage-point cut in imports would cause about a one-half percentage-point cut in GDP. Once imports were reduced by more than one-fourth, the damage would become more significant. The elasticity of GDP reductions with respect to import reductions rises to about one and one-fourth, as import reductions reach one-half. Should imports be cut by more than one-half, massive unemployment and relocation of white labor (as well as of non-white labor) would have begun to occur.

There are four caveats needed before concluding. First, models like the one developed and exercised here are inevitably stylized abstractions of the economy they try to represent. Anyone who has worked with sectoral optimization models (especially for LDCs) knows that they can occasionally

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[1] The goods themselves, not just the capital flow that shows up in the balance of payments.

[2] 5.5 percent over the past quarter century, 4 percent in the 1970s (growth rates per annum of real GDP).

-- and not so occasionally as one would like -- generate nonsense, despite the fact that each ingredient seems a plausible if simplified representation of reality. The proper defense of the model developed here is hardly unbounded faith in complex mathematical modeling but rather a lack of confidence in the alternative, the hidden models that underlie gut reactions and broad judgments.

The second caveat follows the first. Even if the model is a sensible simplified replication of the South African economic structure, that structure might alter dramatically under the pressure of sanctions. The model, with its innately unchanging view of structure, might then forecast quite badly. While such structural change cannot be easily encompassed within a model, it must be remembered that it is also difficult to foresee without a model. This shortcoming is probably not too serious as long as our concern is with the short run. But conclusions about South African growth under sanctions require a strong implicit assumption about South Africa's ability to alter the structure of (i.e., create) its capital goods industries. To the extent that history provides evidence, it is that modern economies fare better than we might expect when struck by calamity.[1] But this recent evidence includes no observations of economies so dualistic and so internally divided at the time of crisis as is South Africa today.

The third caveat, clear to the careful reader of Sections IV and V, is that the model does not remove our uncertainty about the impact of sanctions. Rather, it serves only to locate its source and circumscribe it. In the end, the estimates of the parameters of South Africa's potential for import replacement are largely guesses. The results are not terribly sensitive to variations in these guesses, but they nevertheless are dependent upon them.

Finally, one should recognize that the direction of error of the results is not clear. The model assumes that South Africa maximizes GDP under sanctions, and it would therefore appear that its actual GDP under sanctions would be surely lower than the model estimates. But the model specifies many structural rigidities -- for example, in the composition of consumption and the mobility of white labor -- that may in fact turn out to be quite flexible in a beleaguered South Africa. Accordingly, it is impossible to be sure whether the estimates (presented in Section V) are high or low.

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[1] See, for example, the brief surveys and analyses in Hirshleifer, 1963.

APPENDIX A

THE MODEL

The model of the text is a static linear programming model in which South Africa is assumed to maximize an objective function in the face of various linear constraints. Some, the result of sanctions, are externally imposed constraints on exports, imports and capital flows. The rest of the constraints represent restrictions on South African choices imposed by custom, behavior and technology. In all, three objective functions are considered, 253 variables, and 411 constraints (of which 165 are equalities and 246 are inequalities).[1]

The organization of this appendix is as follows. First, the variables and their symbols are listed and defined. Second, the accounting identities of the model are given. Third, the constraints are discussed. And fourth, the objective function is explained.

Variables. In general, the variables of the model are written as capital letters (parameters and subscripts being written in lower case). There are eight production sectors, referred to with the subscript i or j. There are seven occupations, referred to with the subscript o. Two races of laborers are considered, referred to with the subscript r. All value variables are in rands at 1967 prices.

The variables:

X_j = gross value of output of sector j.

X_{ij} = intermediate input flow of output from sector i to sector j.

C_i = final consumption goods produced by sector i.

I_i = final (fixed and inventory) investment goods produced by sector i.

G_i = final government consumption purchases from sector i.

E_i = exports of sector i.

M_j = imports of intermediate inputs for use in sector j.

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[1] Some of these constraints are altered or eliminated when a less exacting set of policy constraints is considered.

M_C, M_I, M_G = imports of final goods for consumption (C), investment (I), and government (G), respectively.

V_j = value added in sector j.

C = aggregate consumption.

I = aggregate investment.

G = aggregate government current-account expenditure.

E = aggregate exports.

M = aggregate imports.

D = balance-of-trade deficit.

Y = GDP.

W_r = wage earnings of laborers of race r.

N_j = non-wage earnings in sector j.

N = aggregate non-wage earnings.

L_{roj} = laborers of race r and occupation o employed in sector j.

The total potential number of variables is 253, although many of these (especially the inter-industry flows, X_{ij}) will be zero for all simulations. All of the variables, with the sole exception of D, are throughout constrained to be non-negative.

Identities. The total output of a sector[1] (X_i) must be exactly used up, either in intermediate uses (X_{ij}) or in final demands (C_i, I_i, G_i, and E_i):

$$X_i = \sum_j X_{ij} + C_i + I_i + G_i + E_i. \qquad \text{(A-1)}$$

The total value of a sector's output (X_j) consists of intermediate inputs from domestic sectors (X_{ij}) and abroad (M_j) and of value added (V_j):

$$X_j = \sum_i X_{ij} + M_j + V_j. \qquad \text{(A-2)}$$

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[1] The sectors are:

1. Agriculture
2. Mining
3. Manufacturing
4. Construction
5. Electricity
6. Trade
7. Transport
8. Services

See Appendix B for sources and data details.

The aggregates of consumption (C), investment (I), government expenditure (G), and exports (E) consist of the final goods delivered to them from each domestic sector plus those imported directly:

$$C = \sum_i C_i + M_C \quad ; \qquad \text{(A-3)}$$

$$I = \sum_i I_i + M_I \quad ; \qquad \text{(A-4)}$$

$$G = \sum_i G_i + M_G \quad ; \text{ and} \qquad \text{(A-5)}$$

$$E = \sum_i E_i \quad . \qquad \text{(A-6)}$$

Re-exports are ignored in the model so that no M_E is considered.

Aggregate imports (M) are the sum of intermediate good imports into each sector (M_j) and imports of final products for consumption, investment and government expenditure:

$$M = \sum_j M_j + M_C + M_I + M_G \qquad \text{(A-7)}$$

The balance-of-trade deficit (D) is simply the excess of imports over exports:

$$D = M - E. \qquad \text{(A-8)}$$

Aggregate value added, or GDP (Y), is the sum of final goods demands minus imports:

$$Y = C + I + G + E - M. \qquad \text{(A-9)}$$

Value added in each sector consists of wage and non-wage payments to the factors employed in that sector:

$$V_j = \sum_r \sum_o w_{roj} L_{roj} + N_j \quad . \qquad \text{(A-10)}$$

The wage payments in sector j are the product of the wage rate (w_{roj}) and the quantity employed (L_{roj}) of each of the r races and o occupations laborer, summed over r and o. The wage rates are parameters and are assumed not to change over the simulations despite any changes in the employment situation.

The total wage earnings of each of the races (W_r) is the sum of those earnings across sectors and occupations:

$$W_r = \sum_o \sum_j w_{roj} L_{roj} \quad . \qquad \text{(A-11)}$$

Aggregate non-wage earnings are also the sum across sectors:

$$N = \sum_j N_j \quad . \qquad \text{(A-12)}$$

One could also write, as an identity, that GDP (Y) is the sum of income shares, i.e., $Y = \sum_r W_r + N$, but this is not an independent equation; it is derivable from the other identities.

Constraints. There are three kinds of constraints on the South African economy, as reflected in the model. The first are essentially technological, and these are discussed first. Then there are the constraints imposed from abroad -- i.e., by the international sanctions. And finally, there are constraints imposed by the South Africans themselves, through the pressures of culture, behavior and/or policy targets.

The essence of an input-output model is in its recognition of the need for inter-industry flows of intermediate goods. Here this dependence is assumed to be linear and proportional to the gross output of each sector:[1]

$$X_{ij} = a_{ij} X_j \quad . \qquad \text{(A-13)}$$

Production also requires imported intermediate inputs; and in the case of the final demands (private consumption, investment and government consumption), an imported component is demanded. But this model does not assume that the ratios of such imports (M_j) to gross output (X_j) are inflexible.[2] The flexibility is reflected by a range for each such ratio, bounded by an upper and a lower limit. The upper limit is the actual base-year (i.e., pre-sanctions) ratio, m_j; thus,

$$M_j \le m_j X_j \ ,$$

$$M_C \le m_C C \ ,$$

$$M_I \le m_i I \ , \text{ and}$$

$$M_G \le m_G G \ . \qquad \text{(A-14)}$$

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[1] Except in Appendix D and the final simulation of Section V. There (see equation D-12), it is recognized that reductions of intermediate imports, induced by sanctions, will require each sector to utilize not only more labor (see equation A-16) but also increase domestic flows of intermediate goods.

[2] Similarly, the ratios for final demands are permitted some flexibility.

And the lower limit is some fraction, $1 - h_j$, of that base-year ratio:

$$\begin{aligned} M_j &\geq (1 - h_j)\, m_j\, X_j \;, \\ M_C &\geq (1 - h_C)\, m_C\, C \;, \\ M_I &\geq (1 - h_I)\, m_I\, I \;, \text{ and} \\ M_G &\geq (1 - h_G)\, m_G\, G \;. \end{aligned} \tag{A-15}$$

As imports are reduced from their upper limits - i.e., the "normal" base-year levels -- toward their lower limits, ever more labor is required. This import-substitution labor is required in addition to the normal labor needs of production, which are captured here through a linear, proportional (at ℓ_{oj}) ratio of labor to output for each occupation and sector. Labor needs, by sector and occupation (i.e. $\sum_r L_{roj}$), are therefore:

$$\sum_r L_{roj} = \ell_{oj}\,(1 + v_j)\, X_j - \frac{v_j\, \ell_{oj}}{m_j}\, M_j \;. \tag{A-16}$$

Equations (A-16) are fully derived and explained in Appendix C, so it suffices here to notice that the parameter, v_j, indicates the degree of technical difficulty in substituting labor for imported inputs. As v_j goes to infinity, this difficulty becomes insurmountable; at a v_j of zero, no difficulty is encountered.

The model considers the impact of sanctions over a period sufficiently brief that it is impossible for South Africa to augment or sectorally shift its extant capital stock -- this is called "the short run". Accordingly, capital need not be explicitly introduced as a variable in the model, but it must be recognized that capacity limits exist in each sector and that the potential for output increases is limited.[1] Here this limit is expressed as:

$$X_j \leq (1 + b_j)\, \overline{X}_j \;, \tag{A-17}$$

where $\overline{X}_j$ is the base-year value of gross output in j, and b_j is a parameter indicating the degree of excess capacity that can be mobilized when the economy is faced with sanctions.

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[1] The role of capital is spelled out in somewhat greater detail in the course of Appendix C.

[2] In general, a bar over a variable means its base-year value and is interpreted as the pre-sanctions, "normal" value.

In the more highly skilled occupations, there are limits to the rate at which new practitioners can be trained in the short run. This limit is written here for three occupations[1] (professional, administrative and clerical) as:

$$\sum_r \sum_j L_{roj} \leq (1 + q) \sum_r \sum_j \bar{L}_{roj} , \qquad \text{(A-18)}$$

where the parameter q indicates the maximum percentage by which these three kinds of labor can exceed their base-year levels.

Up to now, we have been treating labor in color-blind fashion -- that is, assuming that white and non-white labor are productively interchangeable.[2] Presumably, in the long run, if different races were not hampered by public policy or social custom, labor of different colors would indeed be interchangeable within any correctly defined occupational group. In South Africa, on the other hand, the long history of educational and occupational discrimination against non-whites has meant that they have been relegated to "low-rung" jobs on the occupational ladder. This, together with the fact that this model distinguishes only seven quite broad occupational classifications, means that within any given occupation, blacks and whites are almost certainly not perfectly substitutable for each other. For simplicity in the model, limited substitutability is assumed to mean perfect substitutability within a narrow range and no substitutability beyond that range. The ratio of non-white to white workers (L_{2oj}/L_{1oj}) within any o and j must remain within plus-or-minus s percent of the base-year ratio for that o and j:

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[1] The seven occupations are:
1. Professional
2. Administrative
3. Clerical
4. Sales
5. Farmer
6. Production
7. Service

See Appendix B for sources and data details.

[2] See constraints (A-16) and (A-18); in both, L_{roj} is aggregated, on a one-to-one basis across the races (r). The races are:
1. White
2. Non-White

$$L_{2oj} \geq (1 - s) (\bar{L}_{2oj}/\bar{L}_{1oj}) L_{1oj} \quad \text{, and} \qquad (A-19)$$

$$L_{2oj} \leq (1 + s) (\bar{L}_{2oj}/\bar{L}_{1oj}) L_{1oj} \qquad (A-20)$$

These (constraints (A-13) through (A-20)) are the technological constraints in the model.[1]

International sanctions may provide several kinds of constraints on the operation of the economy. We shall view the sanctions as potentially placing restrictions on all of South Africa's exports, capital inflow and imports, although we shall include formally in the model only two of these three kinds of restrictions. Sanctions could limit the total and/or the composition of South African exports; we shall assume they do both:

$$E_i \leq \tilde{E}_i, \qquad (A-21)$$

where $\tilde{E}_i$ is an exogenously determined maximum which the international community places (and enforces) on exports of sector i.[2] These sectoral maxima for exports imply, of course, a maximum for the total export revenues -- i.e., $E \leq \sum_i \tilde{E}_i$. Secondly, sanctions might reduce the inflow of international capital into South Africa; and we recognize the strong possibility that South Africa, in retaliation, might similarly restrict the outflow of international capital from South Africa. The net effect of such changes will be a limit on the balance-of-trade deficit (D) that South Africa can incur:

$$D \leq \tilde{D} \qquad (A-22)$$

Together with the balance-of-trade identity (A-8), constraints (A-21) and (A-22) imply a limit on total imports, namely, $M \leq \tilde{D} + \sum_i \tilde{E}_i$. Since it is implied, it need not be incorporated explicitly into the model; but its exclusion does mean that we cannot consider the possibility that sanctions mean some sort of sectoral limits, or other compositional limits, on South Africa's imports. Within the overall constraint on M, the M_j are free to vary, subject only to non-negativity and constraints (A-14) and (A-15). Normally, in the simulations, we consider an equal percentage reduction of each E_i and of D, which means in the end of an identical percentage reduction of M. But, in places, we consider a given percentage reduction of each E_i with no change in D from its base-year value. Since the base-year D is negative, this means a larger percentage reduction in M than in E.

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[1] Obviously, constraints (A-19) and (A-20) are not technological constraints in the same sense as the others, that is, in the sense of being irremediably constraining in the long run despite sensible public policy. But in the short run, with which we are concerned, they operate in much the same way as "nature's" constraints.

[2] In general, the tilde over a variable represents an exogenously (from South Africa's viewpoint) determined maximum.

We turn now to the internal South African policy constraints. It should be noted that the difference between what are called "policy constraints" and the ingredients in the objective function which South Africa is assumed to seek to maximize is largely a matter of convenience. The policy constraints are, in a sense, the more important objectives, for the target level of such a constrained variable must be met by the optimal economic program. On the other hand, more than fulfilling this target is assumed to yield no further increment to social welfare. Thus, the constraints discussed below are so treated because of their "threshold" impact on welfare; variables with a continuous, monotonic effect on welfare are reserved for the objective function.

An economy in crisis always has a tough, basic decision to make about investment. A drastic reduction in investment is possible without much short-run impact on output; since more than one-third of South Africa's imports are capital goods, a fairly stiff sanctions-imposed import scarcity could be met simply by ceasing to invest. If the sanctions were believed by South African policy-makers to be a temporary phenomenon, then such a drastic cut in investment might even be a sensible South African reaction.[1] I assume that South Africans would fear sanctions to be a lasting phenomenon and that they would intently guard against any reduction in their current investment (I) and hence their near-term growth rates. Thus, the policy constraint,

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[1] Not necessarily, it must be pointed out. Such a step reduces growth rates for a few years and, ceteris paribus, permanently lowers South African output below the level that would have been achieved if, say, consumption had been cut rather than investment.

$$I = \overline{I} . \qquad \text{(A-23)}$$

Furthermore, the composition of investment would be protected from distortion under the impact of sanctions:

$$I_i = k_i I , \qquad \text{(A-24)}$$

where the parameters, k_i, are derived from the normal, base-year composition of investment.

Similarly, government consumption might seem to provide a temporarily harmless place into which to deflect the import shortages caused by sanctions. But the government usually accounts for only a small percentage of total imports, so little saving can be made there. And more important, in a time of crisis, the government will be needed to provide leadership, continuity and security. Accordingly, we assume that South Africa will insist that government expenditures (G) be maintained,

$$G = \overline{G} , \qquad \text{(A-25)}$$

and the composition of such expenditures not be greatly altered:

$$G_i \geq (1 - u)\, g_i\, G , \text{ and} \qquad \text{(A-26)}$$

$$G_i \leq (1 + u)\, g_i\, G , \qquad \text{(A-27)}$$

where g_i is the base-year (i.e., normal) ratio of G_i to G, and u indicates the degree of flexibility that is permitted in the composition of government expenditures.

In effect, the above restrictions on investment and government consumption mean that the entire burden of sanctions -- however great they are -- will fall on private consumption (C). While the total cannot, therefore, be constrained, the composition of consumption can. We will assume, as we did with government expenditure (constraints (A-26) and (A-27)), that some flexibility is permitted around the base-year composition of consumption:

$$C_i \geq (1 - u)\, c_i\, C, \text{ and} \qquad \text{(A-28)}$$

$$C_i \leq (1 + u)\, c_i\, C , \qquad \text{(A-29)}$$

where c_i is the base-year (i.e., normal) ratio of C_i to C, and u again indicates the degree of flexibility that is permitted in the composition of consumption.[1]

A principal element of South African economic policy over the past half century has been that jobs will be opened to blacks only after white full employment has been assured. There is no reason to think that under sanctions white unemployment will be countenanced as long as it can be avoided. Thus, if there are feasible solutions to the model with the constraint,

$$\sum_o \sum_j L_{1oj} = \sum_o \sum_j \bar{L}_{1oj} , \qquad \text{(A-30)}$$

we shall continue to include it.

Finally, the white-run government would presumably seek to insulate white workers from any upheavals that sanctions might cause. In the model, this effort is incorporated through a restriction on the fraction of white laborers in each occupation (o) and in each sector (j) that can be "uprooted" -- that is, moved to another occupation and/or sector. Thus,

$$L_{1oj} \geq (1 - z) \bar{L}_{1oj} , \qquad \text{(A-31)}$$

for each o and each j, where z is a parameter indicating the maximum fraction of white workers that can be uprooted from any particular job category (i.e., o and j). We shall assume, partly for simplicity and partly because the South African government might seek equality of sacrifice among different classes of white workers, the same value of z for all o and j.

As is seen in the text's discussion of the simulations, not all these constraints can be met when sufficiently large trade and foreign investment reductions are caused by sanctions. In technical terms, for sufficiently low values of $\tilde{E}_i$ and/or $\tilde{D}$, there is no feasible region. When this occurs, we shall assume that some of the policy constraints are relaxed -- indeed, they must be relaxed. Specifically, four of the constraints will then be altered:

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[1] For simplicity, the same values of u are used in all 32 of the constraints, (A-26) through (A-29).

1. The degree of uprooting of whites will no longer be constrained at all -- that is, enforced white labor mobility will be imposed to whatever extent necessitated by the remaining constraints on (and objectives of) the economy. Thus, constraints (A-31) are removed.

2. White full employment is removed as a constraint,[1] and equality (A-30) is weakened to the point that it merely prevents the hiring of more whites than there are in the economy. Thus, (A-30) is replaced by:

$$\sum_o \sum_j L_{1oj} \leq \sum_o \sum_j \bar{L}_{1oj} . \qquad \text{(A-30')}$$

3. It is recognized that government expenditures can no longer be maintained at their pre-sanctions levels. We shall then assume that the compositional restrictions, (A-26) and (A-29), are retained but that the aggregate government consumption is merely kept up to its original level relative to private consumption. Thus, equality (A-25) is replaced by:

$$G = (\bar{G}/\bar{C})\ C. \qquad \text{(A-25')}$$

4. Similarly, the effort to maintain aggregate investment is reluctantly relaxed, and it, too, is simply maintained at its original level relative to consumption. Thus, equality (A-23) is replaced by

$$I = (\bar{I}/\bar{C})\ C. \qquad \text{(A-23')}$$

These four changes in the policy constraint set are made whenever it is necessary to achieve a feasible solution to the economic problem. They are referred to, in the text, as the "less exacting set of policy constraints".

Objective Function. The basic objective function which we assume South Africa would attempt to maximize in the face of international trade and investment sanctions is simply the Gross Domestic Product (Y). Of course, given the identities and constraints above, the maximization of GDP is essentially the same thing as the maximization of aggregate consumption (C).[2] If the South African social welfare objective is a rising monotonic function of the aggregate of net outputs valued at current prices

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[1] White employment is then made part of the objective function (as will be discussed shortly).

[2] See (A-8), (A-9), (A-22), (A-23) and (A-25).

(i.e. of value added), then the maximization of Y (or C) is the maximization of welfare.

Alternatively, one might recognize that Y (or C) includes not only goods and services allocated to whites, but also those consumed by wage-earning non-whites, who, according to all evidence from South Africa, are weighted much less heavily in the white-determined social objective function. Accordingly, one other objective function is examined briefly, namely, the maximization of white incomes, or in symbols, the maximization of $(W_1 + N)$.[1]

Finally, for the full set of constraints in the model -- i.e. all of (A-1) through (A-31) -- there is sometimes no feasible region. Then the less exacting set of policy constraints (just described) is introduced into the model. In that process, it should be recalled, the constraint that white full employment be completely achieved is removed. A feasible region is thereby created, but we do not want to ignore the fact that white employment still matters a great deal to (white) policy makers. A simple way to incorporate this dual concern for output (Y) and white employment $(\sum_o \sum_j L_{1oj})$ is to include them both additively in the objective function,

$$Y + p \sum_o \sum_j L_{1oj} , \qquad \text{(A-32)}$$

where p is the rate at which GDP and white employment substitute for each other (in thousands of rands per worker) in the objective function. This objective function will be used whenever the less exacting set of policy constraints is made necessary.

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[1] It is reasonably assumed that almost all non-wage income (N) accrues to whites.

APPENDIX B

THE DATA

The data requirements of the model transcended the statistics produced by any single official or unofficial South African source. Thus, it has been necessary to take data from various sources and make extensive adjustments in order to create a set of data that is conceptually comparable and internally consistent. The principal sources are: 1) for output, final delivery, and inter-industry trade, Krogh, 1961, and Department of Planning, various years; 2) for international trade and payments, South African Reserve Bank, various years, Department of Customs and Excise, various years, and Department of Statistics, various years; and 3) for employment and wage payments,Department of Statistics, 1960 and 1970.

The need to collect data from different sources resulted in two major shortcomings in the data that were finally used. First, the data in this study (to be presented and discussed shortly) are with few exceptions not quite the same as any of the sources. Thus, what is called "normal" or the "base year" in this study is not discoverable in any official tables. Nor is it suggested that this data, in any of its particular elements, is as accurate as the official data. Rather, the data used in the simulations present an internally consistent and (it is hoped) a broadly correct picture of the South African economy.

The second shortcoming is that, with so many different sources, it has been difficult to put together (in Ann Arbor and in a short time) a complete data set for a recent year. As a result, the base year of the simulations of the text is 1967. The labor and wage data, needed by sector, race and occupation, are inevitably limited by the most recent census[1] except by extrapolation. And the choice of 1967, rather than 1970, was made because that was the latest year for which an input-output table was available.[2] Accordingly, the simulations of the text are all estimates of what would have happened had sanctions been imposed on (the modeled version of) the 1967 South African economy.[1] There have been efforts over the past decade to further insulate South Africa from international sanctions, and to the extent that they have been successful, the impact of sanctions would be relatively smaller than is estimated here. Otherwise, however, the choice of so distant a base year, while unfortunate, should not in itself much bias the resulting estimates.

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[1] For South Africa, 1970.

[2] Implicit in the development program for 1967 (Department of Planning, 1967). Actually, it was largely an updating of the 1956-57 table (Krogh, 1961). I have (too late) discovered a more recent (1971) table (Department of Statistics, 1977).

The order of the remainder of this appendix is as follows. First, the 1967- base year data are shown and their derivation explained. And then the parameters of the model and the procedures of their estimation are reported.

1967 Data. The inter-sectoral and final demand flows were initally constructed from the Economic Development Program for the Republic of South Africa, 1967-72, produced by the Department of Planning. That document differs noticeably from, and presumably is an update of, the input-output accounts for 1956-57.[2] We contracted the number of sectors from 33 to 8, with the following mapping:

No.	Sector Title	Development Program Sectors	I.S.T.C. Sectors
1	Agriculture[a]	1	0
2	Mining	2-4	1
3	Manufacturing	5-27	2-3[b]
4	Construction	28	4
5	Electricity[c]	29	5
6	Trade	30-31	61
7	Transport[d]	32	7
8	Services	33	62, 63, 8

[a] Includes forestry and fishing.

[b] Sector 384 (motor trade) is in Sector 6 (trade).

[c] Includes gas and water.

[d] Includes communications.

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[1] Among other things, this means that all values are in 1967 prices. Real GDP rose by 52% between 1967 and 1977, and the GDP price deflater rose by 135% over that same decade.

[2] By Krogh, 1961.

Some adjustments in the inter-industry flows were immediately necessary: "other sectors" of the Development Program were allocated (proportionately), and the unreported flows for sectors 6 through 8 constructed (by applying the relevant ratios in the 1956-57 table[1] to the gross outputs in 1967). Moreover, the unreported composition of final demand (between private and public consumption) of sectors 6 through 8 had to be estimated from other information.

The intermediate and final flows so obtained displayed some glaring inconsistencies with official South African national accounts data, with smaller value added totals in manufacturing (3), transport (7), and services (8), and a larger total in trade (6). A series of adjustments were therefore made whose intent was to reallocate some of the output attributed (by the Development Program) to "trade" to the sector whose output was "traded" and thus to make the data comparable with the allocation procedures of the national accounts. The entire process converted, in principle if only roughly in fact, the basis of the tables from "producers prices" to "factor costs".

Furthermore, examination suggested that the Development Program accounts did not cover all the sub-sectors of manufacturing (3), transport (7) and services (8). The final adjustment was, quite arbitrarily, to elevate the value added in these sectors to the levels of the national accounts and then to raise all the unknown components proportionately.

The resulting values, for the eight sectors, for 1967, for intermediate and final annual rates of flow, are given in Table B-1. The figures there are all for the source and use of domestic production only (i.e., imports have been removed from each entry). The implied GDP is R 8,156 million.[2]

Since the import data are nowhere explicitly reported by sectors of use, it was necessary to allocate the actual import totals among the producing sectors and the components of final demand. From inspection of

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[1] Krogh, 1961.

[2] Total imports were R 2,440 million. GDP equals the sum of C, I, G and E in Table B-1, less imports of intermediate goods only (i.e., R 1,051 million).

TABLE B-1

PRODUCTION, SOURCES AND USES BY SECTOR, 1967

(R millions)

Sector(j)	1	2	3	4	5	6	7	8	Consumption(C)	Investment(I)	Government(G)	Exports(E)	Gross Output(X)
Agriculture (1)	68	-	797	-	-	4	-	6	268	160	2	275	1,579
Mining (2)	16	19	123	19	36	-	20	1	5	10	4	1,151	1,405
Manufacturing(3)	345	170	2,260	586	5	122	122	152	2,248	250	106	623	6,989
Construction (4)	-	-	2	-	-	-	-	1	-	1,086	-	-	1,089
Electricity (5)	-	57	38	31	8	9	27	11	104	-	19	-	303
Trade (6)	60	54	501	-	2	12	7	5	252	25	17	37	970
Transport (7)	96	86	788	-	3	18	10	8	280	20	17	196	1,522
Services (8)	25	64	130	-	13	166	88	52	1,083	-	705	264	2,587
Value Added	941	953	1,507	414	229	632	1,228	2,253					
Totals:									4,240	1,551	870	2,547	16,445

NOTE: Throughout this appendix, totals may not add because of rounding.

Table Q-10 in the 1970 volume of South African Statistics, it was decided that roughly 21% of total 1967 imports went to final consumption. Of this figure, 84% was allocated to private and 16% to public consumption (the same percentage reported in Table 2-1 of the 1968-73 Economic Development Program). Imports for investment were taken as the "capital equipment" entry. It was assumed that no importing for the purpose of re-exporting occurred. Residual imports were allocated among the eight intermediate sectors on the basis of the data given in Volume 1 of the 1968 Foreign Trade Statistics. This source listed imports by six-digit SITC classification; knowing also the corresponding ISIC classification, one can get a fairly accurate idea of the use for which most imports were destined. Nonetheless, inevitably, a number of cases remained in which it was not clear to which sector or sectors the imports should be allocated. In these instances, imports were distributed on the basis of instinct and/or proportionality.

Two final adjustments were required. First, since many sources and methods were used to determine the allocation of imports among final demands and intermediate sectors, some minor inconsistencies surfaced. Especially, the allocation resulted in figures which were too large in the sense that the sum of sectoral imports plus final-demand imports exceeded the total of 1967 imports. Accordingly, downward adjustments were made, based on relative sectoral size. And second, the Foreign Trade Statistics data did not include the services imports (payments for non-factor services), harbor dues and mail fees which were listed in the Economic Development Program. It was decided to include these figures, the total of which was allocated among the sectors and the final demand components in proportion to their share of other imports. The estimates that resulted are given in Table B-2.

There are labor estimates by race and sector in the Economic Development Program, but for labor data by race, occupation and sector, it is necessary to go to the more comprehensive Population Census. This census has been done recently in South Africa decennially and is available for each of 1960 and 1970. From the national accounts, value added by sector is known for 1960 and 1970; and 1967 value added by sector has already been estimated (Table B-1). The assumption was made that the 1967 ratio of labor to value added for each race, occupation and sector fell along a smooth geometric trend between the 1960 and 1970 values of that ratio. In symbols (see Appendix A for definitions of the variables):

$$L_{roj1967} = V_{j1967} \left(\frac{L_{roj1960}}{V_{j1960}}\right)^{0.3} \left(\frac{L_{roj1970}}{V_{j1970}}\right)^{0.7} \qquad \text{(B-1)}$$

The resulting labor estimates are presented in Table B-3.

Total wage income for whites by sector in 1960 and 1970 is provided by South African Statistics. Dividing these sectoral white wages by the number of white workers in the sector (Table B-3,Part A), yields the average white wage rate by sector in 1960 and 1970. (For some sectors in 1960, no such wage data were available; it was then assumed that the increase in wages there over 1960 to 1970 was equal to the average increase in wages in the other sectors.)

In the population censuses, total white income per occupation is found. However, this number will generally overstate total wages per occupation. To correct somewhat for this, we arbitrarily multiplied total income in the professional, administrative and farming occupations by 0.8 to allow for the fact that these occupations are most likely to display a significant percentage of non-wage income. By dividing the occupational wage total by the numbers of workers in that occupation, we then estimate the average annual wage rate per occupation for whites.

We next assumed that a white worker's annual wage rate was equal to 1/2 the sum of the average wage rate for the occupation plus the average wage rate of the sector to obtain estimates of the average annual wage rate per white worker in 1960 and 1970 for all 56 cells (i.e. 7 occupations, 8 sectors). These wage rates were put into 1967 prices by use of the consumer price index, and the 1967 wage rate was assumed to lie, for each occupation and sector, along the smooth geometric trend from the 1960 to 1970 values. In symbols,

$$w_{1oj1967} = \left(w_{1oj1960}\right)^{0.3} \left(w_{1oj1970}\right)^{0.7} \qquad \text{(B-2)}$$

These are given in Part A of Table B-4.

TABLE B-2

IMPORTS, BY SECTORAL SOURCE AND DESTINATION, 1967
(R millions)

Sector (j)	1	2	3	4	5	6	7	8	Consumption(C)	Investment(I)	Government(G)	Total
Agriculture (1)	9	-	38	-	-	3	-	-	33	-	5	89
Mining (2)	4	-	117	0	0	-	-	-	0	-	-	121
Manufacturing(3)	10	1	535	40	5	3	21	24	321	871	62	1,892
Construction (4)	-	-	-	-	-	-	-	-	-	-	-	-
Electricity (5)	-	-	-	-	-	-	-	-	-	-	-	-
Trade (6)	-	-	-	-	-	-	-	-	-	-	-	-
Transport (7)	0	-	10	-	0	0	0	1	5	-	1	18
Services (8)	5	-	145	-	3	2	5	72	74	-	14	320
TOTAL	27	1	845	40	8	8	26	97	434	871	83	2,440

NOTE - means zero; 0 means less than R 0.5 million (and similar notation is used throughout this appendix).

TABLE B-3

LABOR, BY RACE, OCCUPATION, AND SECTOR, 1967

(thousands of workers)

A. WHITES

Sector (j) / Occupation (o)	1	2	3	4	5	6	7	8	Total
Professional (1)	1	5	19	7	2	4	10	142	191
Administrative (2)	1	1	16	9	0	9	7	17	61
Clerical (3)	1	7	44	7	2	31	88	160	340
Sales (4)	0	0	11	1	0	53	1	13	79
Farmer (5)	107	0	0	0	0	0	0	2	109
Production (6)	2	44	102	74	8	18	99	24	371
Services (7)	0	1	2	0	0	4	5	26	38
Total	112	58	194	99	13	120	209	385	1,190

B. NON-WHITES

Sector (j) / Occupation (o)	1	2	3	4	5	6	7	8	Total
Professional (1)	0	1	1	0	0	1	0	102	105
Administrative (2)	0	0	0	1	0	1	0	3	5
Clerical (3)	1	8	21	4	1	11	4	26	76
Sales (4)	0	0	3	0	0	49	0	3	55
Farmer (5)	2,249	2	2	1	0	1	0	57	2,311
Production (6)	20	539	431	340	28	91	62	107	1,617
Services (7)	4	16	17	5	2	28	4	935	1,010
Total	2,274	566	475	350	31	182	70	1,231	5,179

TABLE B-4

WAGE RATES, BY RACE, OCCUPATION, AND SECTOR, 1967

(R thousands per worker)

Sector(j) / Occupation (o)	1	2	3	4	5	6	7	8
				WHITES				
Professional (1)	1.40	3.07	2.55	2.00	2.36	2.22	2.61	2.48
Administrative (2)	2.36	3.40	3.47	2.37	3.30	3.18	3.56	3.46
Clerical (3)	1.07	2.74	2.23	1.68	2.92	1.88	2.27	2.17
Sales (4)	1.47	3.09	2.62	2.07	2.41	2.30	2.67	2.57
Farmer (5)	1.28	2.95	2.42	1.87	2.23	2.22	2.52	2.49
Production (6)	1.34	3.05	2.52	1.98	2.31	2.19	2.57	2.46
Services (7)	1.21	2.74	2.21	1.67	2.01	1.89	2.32	2.15

Sector(j) / Occupation (o)	1	2	3	4	5	6	7	8
				NON-WHITES				
Professional (1)	0.09	0.19	0.64	0.38	0.28	0.32	0.45	0.34
Administrative (2)	0.15	0.24	0.88	0.56	0.38	0.44	0.63	0.49
Clerical (3)	0.07	0.17	0.56	0.31	0.23	0.26	0.40	0.31
Sales (4)	0.09	0.20	0.66	0.40	0.28	0.32	0.47	0.36
Farmer (5)	0.08	0.18	0.61	0.35	0.26	0.31	0.44	0.35
Production (6)	0.08	0.19	0.63	0.37	0.27	0.31	0.46	0.35
Services (7)	0.07	0.17	0.56	0.31	0.24	0.26	0.41	0.30

Non-white wages present an additional problem as the censuses contain *no* income data for blacks. The *only* useful data along these lines is the sectoral total wages of non-whites, published annually in *South African Statistics*. Accordingly, it is necessary to assume that the ratio of non-white to white wage rates, within any occupation and sector, is equal to the average non-white wage rate in that sector divided by the average white wage rate in that sector.[1] In symbols,

$$w_{2oj} = w_{1oj} \frac{\sum_{o} W_{2oj}}{\sum_{o} w_{1oj} L_{2oj}} . \qquad \text{(B-4)}$$

Thus, as can be seen in Part B of Table B-4, much of the occupation-and-sector detail of non-white wages is specious. Furthermore, in order to avoid detailed research into the functioning of labor markets, we assume that these wage rates do not change during the simulations, no matter how much unemployment or labor re-allocation occurs. For these reasons, the wage implications of sanctions, as determined by the simulations, are reported sparingly and tentatively.

Finally, with the labor data of Table B-3 and the wage rate data of Table B-4, the value added of each sector (see Table B-1) can be divided into white wage income, non-white wage income and non-wage income. This is shown in Table B-5.

Parameters. In their simplest form, inter-industry flows are assumed proportional to the gross output of the receiving sector (equation A-13). Thus, appropriate divisions with the data of Table B-1 yield the input-output coefficients (a_{ij}) of the South African economy, shown in Table B-6.

The various import coefficients (m_j) are also readily produced by division, with Table B-2. Since there is no particular value with the model we are using to estimating m_{ij} (i.e. by foreign source sector i as well as by South African use sector j), the import values are added

---

[1] The average white wage rate being calculated using non-white labor weights, i.e., as

$$\frac{\sum_{o} w_{1oj} L_{2oj}}{\sum_{o} L_{2oj}} . \qquad \text{(B-3)}$$

TABLE B-5

DIVISION OF VALUE ADDED BY INCOME SHARES, 1967

(R millions)

Share Sector (j)	White Wage Income (W_1)	Non-White Wage Income (W_2)	Non-Wage Income (N)	Value Added (V)
Agriculture (1)	144	182	615	941
Mining (2)	176	107	670	953
Manufacturing (3)	493	297	717	1,507
Construction (4)	197	129	87	413
Electricity (5)	31	8	189	228
Trade (6)	267	55	310	632
Transportation (7)	518	32	678	1,228
Services (8)	914	382	957	2,253
Total	2,740	1,193	4,223	8,156

TABLE B-6

INPUT-OUTPUT COEFFICIENTS (a_{ij})

Using Sector (j) Producing Sector (i)	1	2	3	4	5	6	7	8
Agriculture (1)	.043	-	.144	-	-	.004	-	.002
Mining (2)	.010	.013	.018	.017	.120	-	.013	.000
Manufacturing (3)	.219	.121	.323	.538	.017	.126	.080	.059
Construction (4)	-	-	.000	-	-	-	-	.000
Electricity (5)	-	.041	.005	.029	.027	.009	.016	.004
Trade (6)	.038	.038	.072	-	.005	.012	.004	.002
Transportation (7)	.061	.061	.113	-	.009	.019	.007	.003
Services (8)	.016	.046	.019	-	.043	.171	.056	.020

vertically before being divided by gross output of the receiving sector. The resulting import ratios (m_j), needed for inequalities (A-14) and (A-15), are shown in Table B-7.

The labor-output coefficients (ℓ_{oj}) of equations (A-16) are not calculated by race, so the total number of laborers in each occupation and sector (i.e. $\sum_r L_{roj}$) is divided by the gross output of the sector. These coefficients are presented in Table B-8.

The sectoral composition of the totals for consumption (C), investment (I) and government expenditure (G) is assumed, for constraints (A-24) and (A-26) through (A-29), to be simply the relevant proportion in 1967. These ratios are reported in Table B-9.

For none of the remaining parameters is there hard evidence, from the base-year accounts estimated above or elsewhere. The values inserted for the simulations of the text are arbitrary and based on little more than intuition. For this reason, it was necessary to use much of the scarce computer budget conducting sensitivity tests on these parameters. The basic values given to these essentially arbitrary parameters are as follows:

Parameter	Basic Value
v_j	2.00
b_j	0.10
q	0.10
s	0.10
u	0.10
z	0.10
p	1.00

In general, the sensitivity tests moved each parameter value by 40% of its basic value in the direction that hurt South Africa's ability to produce GDP.

The values of the various h parameters were constructed only after perusing carefully the kinds of imports brought into each sector. The value of h for each j (and for C, I, and G as well) represents a judgment

TABLE B-7

IMPORT COEFFICIENTS (m_j)

Sector (j)	Coefficient (m_j)
Agriculture (1)	.017
Mining (2)	.001
Manufacturing (3)	.121
Construction (4)	.037
Electricity (5)	.025
Trade (6)	.008
Transportation (7)	.017
Services (8)	.038
Consumption (C)	.093
Investment (I)	.360
Government Consumption (G)	.087

NOTE: The final three coefficients are the m_C, m_I, and m_G, respectively, of inequalities (A-14) and (A-15).

TABLE B-8

LABOR-OUTPUT COEFFICIENTS (ℓ_{oj})

(workers per R million)

Sector (j) Occupation (o)	1	2	3	4	5	6	7	8
Professional (1)	0.98	3.98	2.92	6.92	6.68	4.60	6.77	94.24
Administrative (2)	0.37	1.02	2.42	9.55	0.42	10.02	5.08	7.77
Clerical (3)	1.67	10.89	9.21	10.39	9.31	43.69	61.42	70.85
Sales (4)	0.20	0.18	1.95	1.00	0.40	105.74	0.68	6.17
Farmer (5)	1491.79	1.30	0.33	0.50	1.02	1.17	0.34	22.64
Production (6)	13.88	418.01	76.25	379.58	118.68	112.62	128.70	50.64
Services (7)	2.69	11.90	2.70	4.47	7.64	32.92	7.13	371.26

TABLE B-9

SECTORAL COMPOSITION OF CONSUMPTION, INVESTMENT, AND GOVERNMENT

Sector (i)	Fraction of total in that sector of Consumption (c_i)	Investment (k_i)	Government (g_i)
Agriculture (1)	.057	.066	.002
Mining (2)	.001	.004	.004
Manufacturing (3)	.481	.103	.111
Construction (4)	-	.448	-
Electricity (5)	.022	-	.020
Trade (6)	.054	.010	.018
Transportation (7)	.060	.008	.018
Services (8)	.232	-	.739

about how large a percentage of these imports can be replaced.[1] The basic values of these h parameters are:

Subscript of h	Basic Value
j = 1	0.450
2	0.500
3	0.250
4	0.275
5	0.475
6	0.425
7	0.325
8	0.325
C	0.500
T	–[2]
G	0.250

The (weighted by inputs) average value of all these h's is 0.213 -- that is about one of every five rands of imports is assumed to be replaceable by domestic production (at a cost). The time-span is critical for discussion of values for the h's -- in the very long run, almost all values of h are one. We are considering a fairly short period. But even smaller values of the h's are tried as sensitivity tests, namely, each h value reduced 40% below its value in the above table.

For the "greatest impact" simulation (the results of which are described in Section V of the text), the following changes were made from the basic model and parameter values:

1. Objective function (A-32) is used, with $p = 2$.
2. The "less exacting set of policy constraints" is applied (see Appendix A for the definition).
3. The production function of Appendix D is used (see equation (D-12)).
4. All exports except those of the mining sector are cut to zero (i.e. $E_1 = E_3 = E_4 = E_5 = E_6 = E_7 = E_8 = 0$). Mining exports ($E_2$) are assumed to be not affected by sanctions, but no trade imbalance can occur (i.e. $D = 0$).

---

[1] If they are replaced, it of course means a higher labor cost -- see Appendix C.

[2] i.e., zero -- no replacement possible.

5. All import-substitution limits (i.e., the h_j's) are reduced by 40%, and the following other parameters are also stiffened:

Parameter	In Equation	Value	
		Basic	"Greatest Impact"
v_j	A-16	2.00	2.80
b_j	A-17	0.10	0.06
q	A-18	0.10	0.06
s	A-19,20	0.10	0.06
u	A-26,27, 28,29	0.10	0.06

APPENDIX C

THE SHORT-RUN POTENTIAL FOR IMPORT SUBSTITUTION, AS INCORPORATED IN THE MODEL

According to neo-classical production theory, output in j (X_j) is some function (f) of the inputs into the sector. For our purposes four kinds of inputs are relevant: 1) labor of the oth occupation (L_{oj}, where o = 1, ..., 7); 2) intermediate inputs delivered from the ith South African sector (X_{ij}, where i = 1, ..., 8); 3) non-competing[1] intermediate-input imports from the rest of the world (M_j); and 4) the capital stock available ($\bar{K}_j$, where the bar indicates that it is fixed in the short run, with which we are concerned). In symbols,

$$X_j = f\,[L_{oj}, X_{ij}, M_j, \bar{K}_j] \ ,$$

where o = 1, ..., 7 and
i,j = 1, ..., 8. (C-1)

For simplicity in what follows, we will suppress all subscripts and ignore the domestically-produced intermediate inputs (X_{ij}).

If the elasticity of substitution in (C-1) were zero, it could be rewritten as

$$X = \text{Min}\,[L/\ell, M/m, \bar{K}/k] \ , \qquad \text{(C-2)}$$

where ℓ, m, and k are the relevant input-per-unit-of-output ratios.

Equation (C-2) embodies essentially the assumption about production made in the model, except that one explicit element of substitutability is introduced -- namely, that additional labor (i.e. beyond the needed ℓX) can be used to replace imports should they fall below mX.[2] One way to introduce this substitutability and still retain the linearity of the equations of the model is the following:

---

[1] By non-competing is meant that the products are not produced in South Africa.

[2] There is also an implicit substitutability, namely that $\bar{K}$ is adequate to produce levels of X slightly above the base-year values (see equation (A-17) of Appendix A). Excess capacity, which appears whenever $X < \bar{X}$, is assumed not to be substitutable for either labor or imports.

$$L = [1 + v (1 - \frac{M/X}{m})] \ell X . \qquad (C-3)$$

With (C-3), the labor requirement is ℓX as long as the full import need is fulfilled (i.e. as long as $M = mX$); but L will exceed ℓX if the ratio, M/X, falls below m.

Clearly, there are limits to the extent to which labor can substitute for imports. This is reflected in the model by an inequality to insure that[1]

$$M \geq (1 - h) mX \quad , \qquad (C-4)$$

where h is a parameter expressing the maximum import substitution through labor use.

Two isoquants, for $\bar{X}$ and for $\bar{X}/2$, are drawn in Figure C-1, which show the rate and range of substitutability of L for M. Only the negatively sloped parts of the isoquants are relevant since there are limits to the direction and extent of the substitutability (i.e. $(1 - h) m X \leq M \leq m X$). The slope of this negatively sloped segment is (in absolute value) $m/v\ell$. The vertical and horizontal parts of the isoquants are sketched in, but they are never relevant since both imports and labor are scarce in the model.

The meaning of the parameter, h, is clear. It indicates the extent to which import replacement (by labor) is feasible. The meaning of the parameter, v, is less obvious. It is a pure (positive) number which indicates the rate at which labor substitutes for imports. The higher is v, the more labor required per unit of imports replaced.

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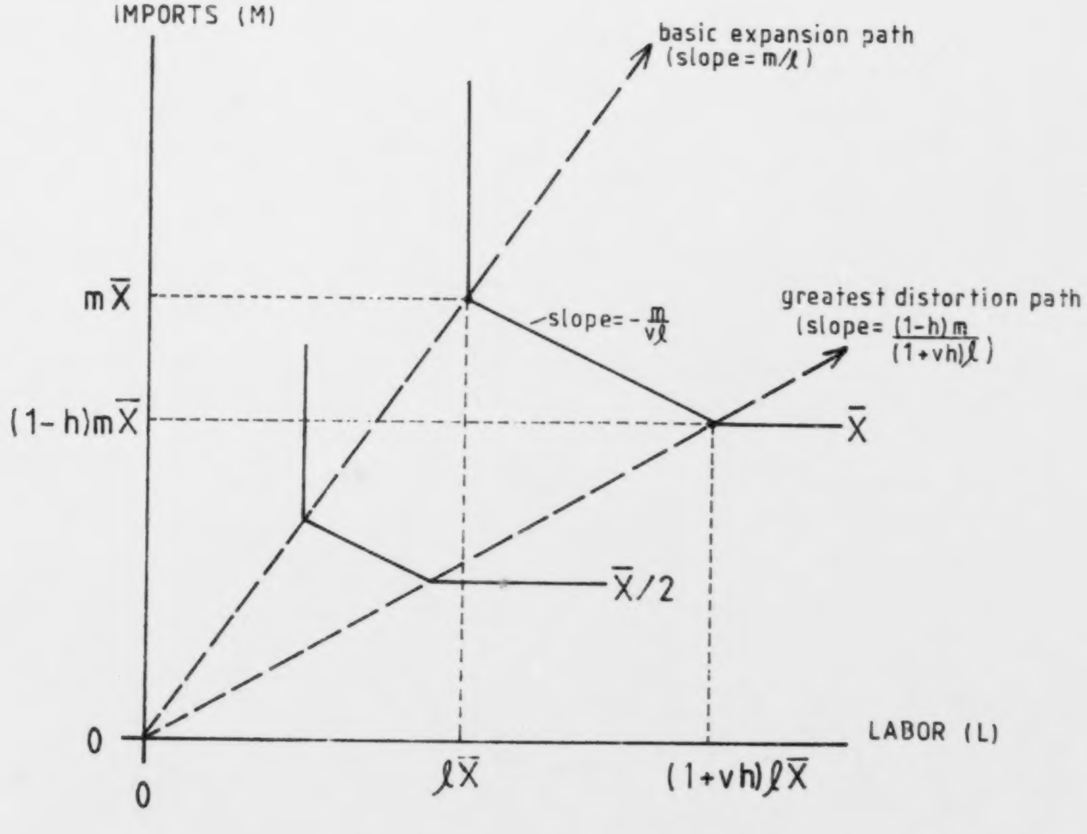
[1] There is also an inequality, $M \leq mX$ to indicate that imports cannot be used to replace labor.

FIGURE C-1

Import-Labor Isoquant Pattern


IMPORTS (M)
basic expansion path
(slope = m/ℓ)
$m\bar{X}$
slope= $-\frac{m}{v\ell}$
greatest distortion path
(slope= $\frac{(1-h)m}{(1+vh)\ell}$)
$(1-h)m\bar{X}$
$\bar{X}$
$\bar{X}/2$
0
LABOR (L)
0
$\ell\bar{X}$
$(1+vh)\ell\bar{X}$

APPENDIX D

EARLIER INPUT-OUTPUT ANALYSES OF THE IMPACT OF SANCTIONS

There have been two previous studies of the potential impact of general economic sanctions that have used an input-output framework, one an eight-sector analysis of Rhodesia (Curtin and Murray, 1967) and the other a thirteen-sector analysis of South Africa (Spandau, 1978). Each employed a model considerably simpler than the present model. This appendix examines their methods.

For simplicity, the models are described for two sectors only, and intra-sector intermediate-good flows are ignored (i.e. $a_{ii} = 0$ for $i = 1, 2$). The basic explicit equations of the models are:

$$X_1 - a_{12} X_2 - F_1 = 0 \text{ , and} \tag{D-1}$$

$$- a_{21} X_1 + X_2 - F_2 = 0 \text{ ,} \tag{D-2}$$

where X_i = gross output of the i^{th} sector, a_{ij} = inter-industry intermediate-good flow from sector i to sector j, and F_i = final goods (i.e. consumption, investment, government and exports) delivered by sector i. Implicit in the model are two other sets of equations:

$$M_j = m_j X_j \qquad (j = 1, 2) \text{ , and} \tag{D-3}$$

$$V_j = v_j X_j \qquad (j = 1,2) \text{ ,} \tag{D-4}$$

where M_j = intermediate-good imports into the j^{th} sector, m_j = the average (and marginal) import propensity of sector j, V_j = value added in j, and v_j = the average (and marginal) ratio of value added to gross output in j. All the capital-letter variables (i.e. X, M, and V) are in value terms, so that

$$a_{21} + m_1 + v_1 = 1 \text{ , and} \tag{D-5}$$

$$a_{12} + m_2 + v_2 = 1 \text{ .} \tag{D-6}$$

Once the final demands (F_i) are known, equations (D-1) and (D-2) yield the solution values of the gross outputs (X_i); then, imports (M_j) and value added (V_j) can be found by use of equations (D-3) and (D-4). The solution process can be seen in Figure D-1, where equations (D-1) and (D-2) are graphed and the solution shown at

$$X_1 = \frac{F_1 + a_{12} F_2}{1 - a_{12} a_{21}} \text{ , and} \qquad \text{(D-7)}$$

$$X_2 = \frac{F_2 + a_{21} F_1}{1 - a_{12} a_{21}} \text{ ,} \qquad \text{(D-8)}$$

where ($1 - a_{12} a_{21}$) is positive (i.e. the Hawkins-Simon condition).

There are two methods by which the potential impact of sanctions are estimated. Both studies (i.e. Curtin and Murray, 1967 and Spandau, 1978) use the first; only the former uses the second method.

Method 1. Sanctions mean an agreement by the rest of the world to purchase fewer exports from the target country, hence a reduction in F_i. The gross output equations (D-1) and (D-2), are shown in Figure D-2, solid lines for before sanctions and dashed lines for after sanctions.[1] Clearly, the equilibrium values of each of X_1 and X_2 decline, and so also must imports (M_1 and M_2) and value added (V_1 and V_2) decline.

The magnitude of these changes is substantial. Curtin and Murray, 1967, assume that sanctions would reduce the total exports of Rhodesia by 59% (p. 45); total value added (i.e. GDP) would decline by 16% as a result. Spandau (1978) considers separately the impact of a 20% and 50% decline due to sanctions of exports and of investment; his resulting estimates of percentage GDP declines are shown in Table D-1. The results are additive; thus Spandau estimates that if sanctions reduced both exports and foreign investment by 50%, GDP would decline by roughly 14%. Coincidentally, the

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[1] A decline in F_1 lowers the intercept of equation (D-1), and a decline in F_2 raises the intercept of equation (D-2). In neither case is the slope affected.

FIGURE D-1

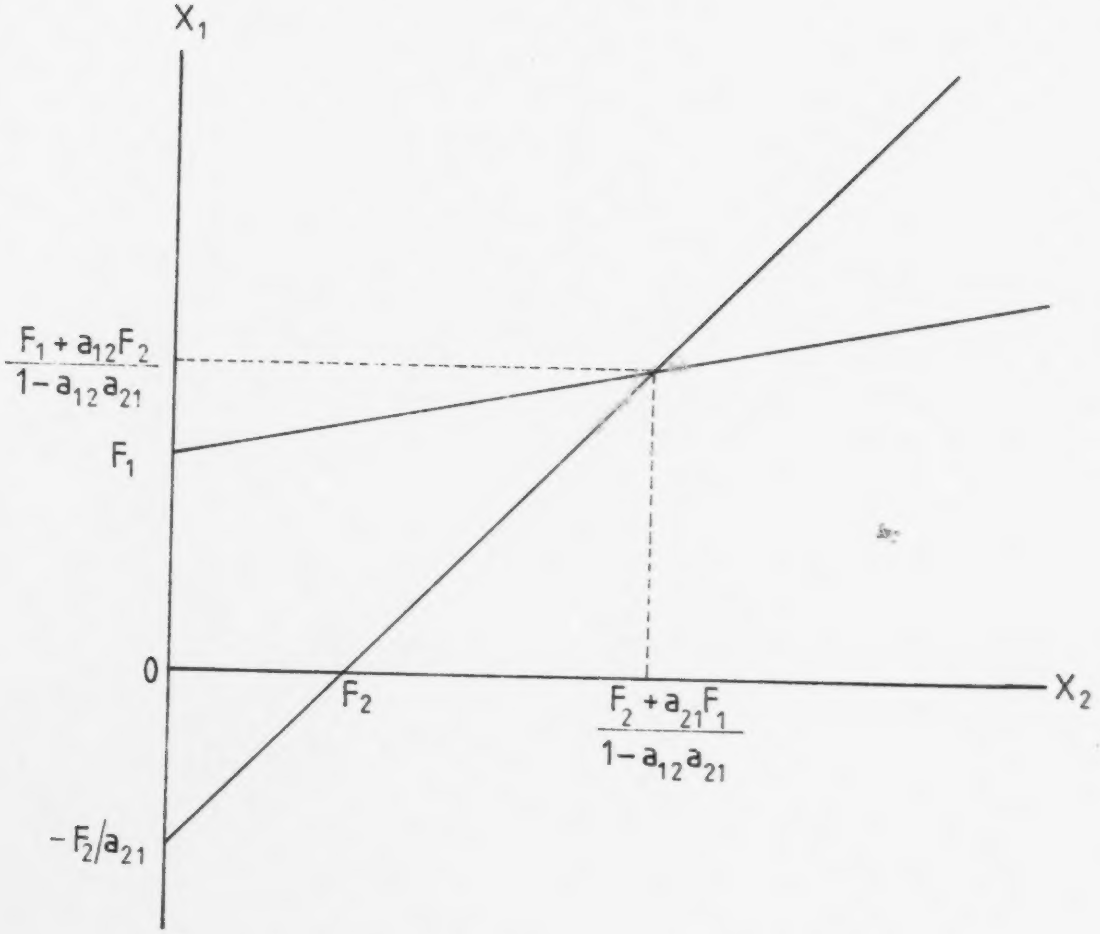

X_1
$\frac{F_1 + a_{12}F_2}{1 - a_{12}a_{21}}$
F_1
0
$-F_2/a_{21}$
F_2
$\frac{F_2 + a_{21}F_1}{1 - a_{12}a_{21}}$
X_2

FIGURE D-2

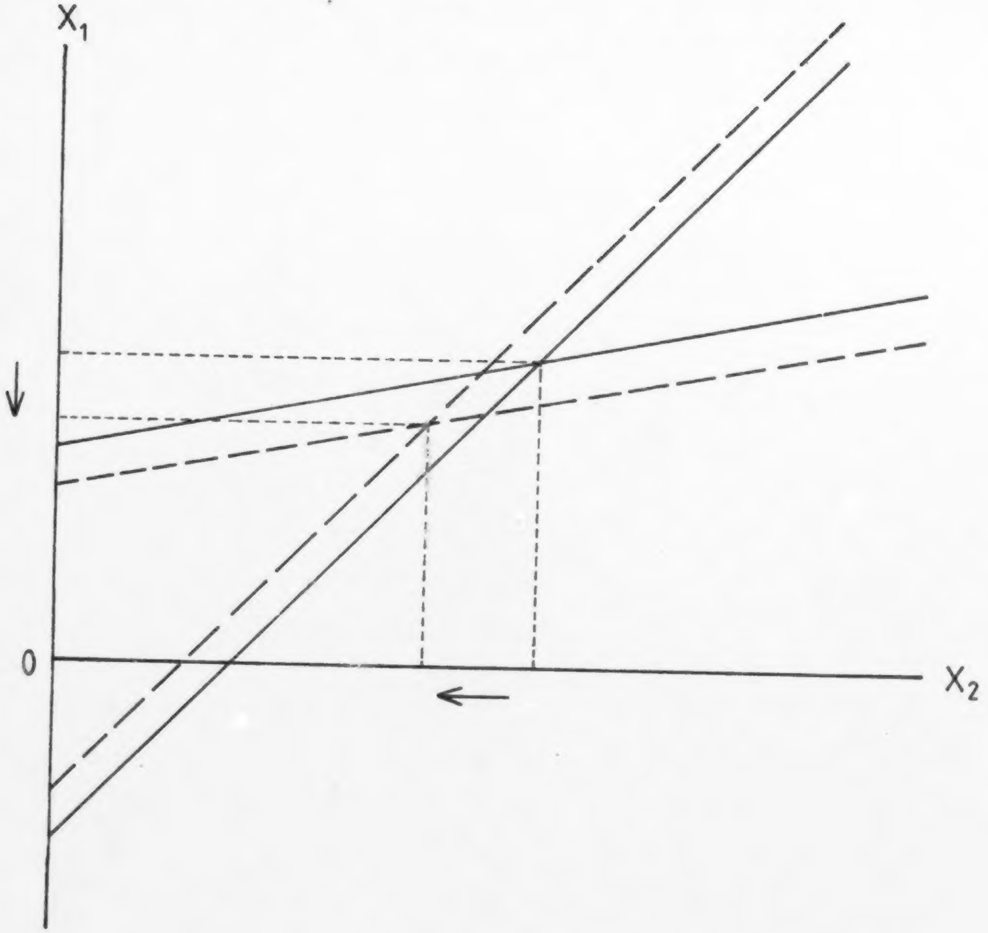


TABLE D-1

PERCENTAGE DECLINES OF GDP ESTIMATED BY SPANDAU[a]

Sanction-Induced Change		Resulting Percentage Decline in GDP[b]
Export Fall	- of 20%[c]	5.17%
	- of 50%[c]	12.92%
Investment Fall	- of 20%[d]	0.53%
	- of 50%[d]	1.33%

[a] Spandau, 1978, pp. 231 ff.

[b] Based on a 1976 GDP of R 29 billion.

[c] Uniform across sectors.

[d] Percentage of foreign investment in each sector.

results of the two studies are surprisingly similar: each percentage point decline in final demand reduces GDP by about one-fourth to one-third as many percentage points.

The straightforward simplicity of the method is attractive, but it contains two fundamental difficulties. First, it assumes that the target economy is unable or unwilling to offset the decline in exports (or foreign investment) by an expansion of consumption, domestic investment and/or government expenditures. In essence, sanctions are viewed as imposing a "Keynesian" recession through reduced aggregate demand upon the target country. It is unlikely, in fact, that South Africa would so quietly acquiesce in the face of sanctions. The Rhodesian data certainly indicate that no such passivity occurred there. Between 1965 and 1968, sanctions forced a reduction of $R 114.8 millions in the annual rate of exports (in 1965 prices);[1] meanwhile the sum of the annual rates of consumption, investment and government expenditures rose by $R 103.7 millions, almost exactly offsetting the export decline.[2]

The second difficulty is that there is no balance-of-payments constraint in the picture. The real cost of the loss of exports is the loss of foreign exchange with which to import. Seen through the simple two-sector model developed here, the total imports (M) needed by the economy are

$$M = M_1 + M_2 = \left[\frac{m_1 + m_2 a_{21}}{1 - a_{12} a_{21}}\right] F_1 + \left[\frac{m_2 + m_1 a_{12}}{1 - a_{12} a_{21}}\right] F_2 . \qquad \text{(D-9)}$$

Declines in exports (i.e. in F_1 and/or F_2) will reduce import needs, but not necessarily on a one-to-one basis. For example, a small change in exports in sector 1 (i.e. dF_1) will cause a change in imports (dM) of

$$dM = \frac{m_1 + m_2 a_{21}}{1 - a_{12} a_{21}} dF_1 , \qquad \text{(D-10)}$$

---

[1] $R means Rhodesian dollars, worth U.S.$1.40 during 1965-1968.

[2] Source: I.B.R.D., 1977, pp. 198-199.

where d refers to the time differential. Similarly, for dF_2,

$$dM = \frac{m_2 + m_1 a_{12}}{1 - a_{12} a_{21}} dF_2 . \qquad (D-11)$$

Thus, we can only be sure that the balance of payments will not deteriorate if dM/dF_1 and dM/dF_2 are both greater than one, which implies a very narrow range of values for a_{12}, a_{21}, m_1 and m_2.[1] And, if the balance of payments does deteriorate, then an important impact of sanctions is being neglected by this model. This is not just a remote possibility, as the Curtin and Murray study shows. In their calculations by this method, Rhodesian exports are expected to decline by \$R 107.1 million, while imports are expected to fall by only \$R 15.4 million. But this method never raises the question of how Rhodesia is to finance, while under sanctions, this addition of \$R 91.7 million to its balance-of-payments deficit.

Method 2. Sanctions mean a reduction in the availability of imports to the target country, and the logical response is import substitution. This method focuses on the process whereby imported intermediate inputs (i.e. the M_j of equations (D-3)) become produced domestically and hence are provided through an increase in the various a_{ij}'s. As applied by Curtin and Murray, the method assumes that v_j is unchanged in the process of import-substitution so that $m_j + \sum_i a_{ij}$ is a constant for each sector j. Thus any reduction in m_j is accompanied one-for-one by increases in the various a_{ij}'s.

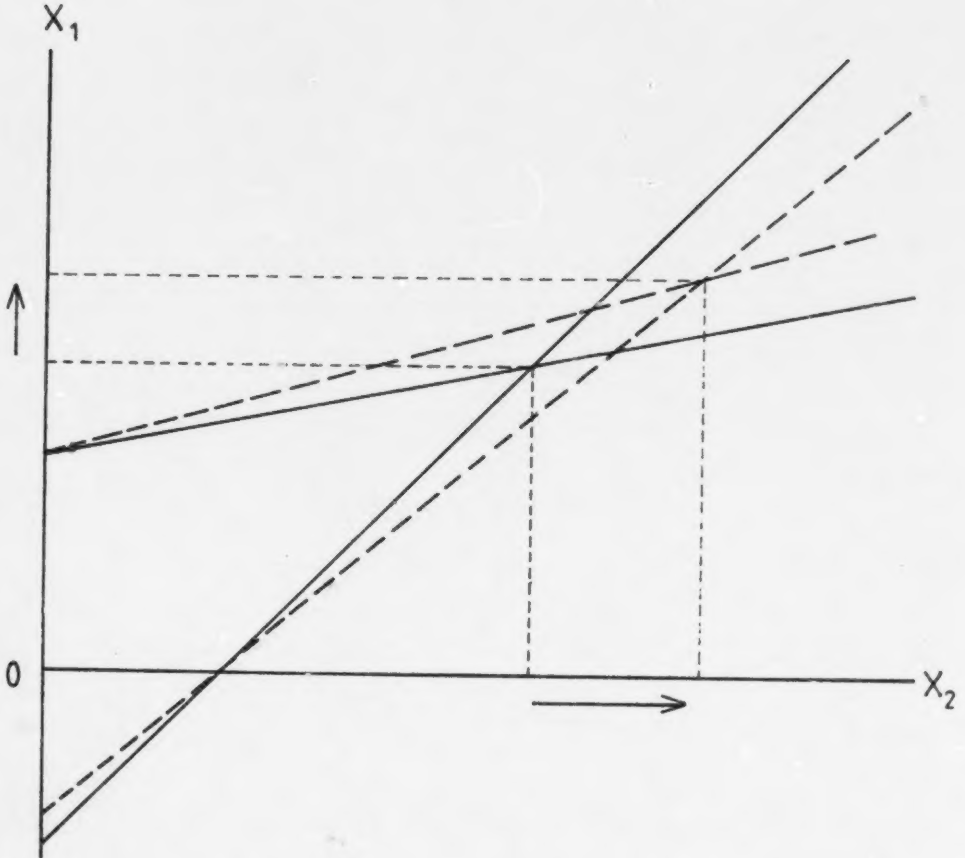
Increases in a_{12} affect only equation (D-1) and increases in a_{21} only (D-2). Figure D-3 shows the effect of an increase in both a_{12} and a_{21}; the solid lines represent equations (D-1) and D-2) before the increase and the dashed lines after. Clearly, the increases in a_{12} and a_{21} cause an increase in both X_1 and X_2.[2]

---

[1] Recall that $(1 - a_{12} a_{21})$ must be positive.

[2] An increase in either a_{12} or a_{21} will cause a rise in both X_1 and X_2. Of course, there is no assurance that all this "import substitution" will reduce total imports (M) since the larger values of X_1 and X_2 offset, to some extent at least, the lower values of the average propensities to import.

FIGURE D-3



The estimated magnitudes of these changes can be large. Curtin and Murray assume that, on average, the Rhodesian values of m_i can be reduced by almost one third of their pre-sanctions (1965) values. As a result, Rhodesian inter-industry deliveries rise from 19% to 21% of gross output and GDP rises by nearly 14%.[1] Total imports decline from \$R 133.8 million to \$R 93.7 million and the balance-of-payments deficit greatly improves -- though after sanctions there is still a deficit \$R 51.6 million larger than before.

This approach is much more in tune with reality than Method 1 (even though it, too, suffers the defect of permitting a larger balance-of-payments deficit to appear). Import substitution *did* take place in Rhodesia during the immediate years after sanctions were imposed. The ratio of imports to GNP fell from 44% in 1965 to 28% in 1969,[2] almost exactly the percentage decline forecast by Curtin and Murray. Nevertheless, the method does beg the question of why this import substitution did not occur earlier and "naturally." There is no cost to it: each reduction in imports is exactly matched in value (i.e. cost) by an increase in domestic inter-industry deliveries. In the model developed here, such a cost is introduced into the labor requirements. If intermediate imports are cut, the labor-output ratios rise (see equation (A-16) of Appendix A).

Ideally, both methods would be used, that is, a reduction in intermediate imports would trigger *both* increased domestic inter-industry flows *and* higher labor requirements. But the cost, in complexity and computation time, is not low. To indicate the kind and extent of the differences this extension would make, however, one such run was made, for 1) a 40% reduction in all exports and the balance-of-trade deficit; 2) an objective function of $Y + \sum_o \sum_j L_{ioj}$; 3) $I = 0.4925\ C$; 4) $G = 0.1939\ C$; and 5) the 56 constraints, $L_{ioj} \geq 0.90\ \bar{L}_{ioj}$, suppressed.[3] Only two differences exist between the simulations presented below. The "basic" simulation, just like those of the text, sets all the values of v_j in equation (A-16) equal to

---

[1] All this is *ceteris paribus*, after exports have been cut by 59%. The numbers in this paragraph can be calculated from Tables 12 and 14 of Curtin and Murray, 1967.

[2] I.B.R.D., 1977, pp. 198-199.

[3] I.e., the less exacting set of policy constraints (as defined in Appendix A).

2.0 and uses the simple form of equation (A-16). The simulation reported here, called the "D" simulation for the appendix in which it appears, reduces the labor cost of import substitution (each v_j is cut to 1.0) and increases the domestic intermediate-input cost. To do the latter, equations (A-16) are replaced by:

$$X_{ij} = a_{ij} X_j + \frac{a_{ij}}{\sum_i a_{ij}} [m_j - \frac{M_j}{X_j}] X_j . \qquad \text{(D-12)}$$

The second term on the right-hand side of equations (D-12) insures that, as M_j falls below $m_j X_j$, the shortage is delivered domestically through $\sum_i X_{ij}$.

The differences between the two simulations are not large, as Table D-2 shows. The aggregate outputs (GDP) simulated are almost identical, and in only two sectors are the differences in value added as large as 5%. White full employment is achieved in both cases. The only notable difference is in non-white employment (and to a lesser extent in non-white wages). This single simulation, if it is systematic, suggests that the text model is greatly overstating the extent to which non-white employment would be stimulated in response to sanctions. This is easily understood: in the "D" simulation, non-white labor cannot replace imports as easily as is assumed in the text simulations. The "D" simulation seems to produce an intuitively more plausible non-white employment result; accordingly, the non-white employment and wages simulations reported in the text must be taken with especial caution.

TABLE D-2

DIFFERENCES BETWEEN THE TEXT RESULTS AND THE "D" SIMULATION

Variable (Symbol)[a]		Value Simulated by Text Model	Value Simulated by "D" Simulation	Percentage Difference[b]
GDP (Y)		6,260	6,273	0.2%
Value Added in				
Agric.	(V_1)	705	729	3.4
Mining	(V_2)	597	604	1.2
Manuf.	(V_3)	1,279	1,293	1.1
Constr.	(V_4)	314	310	1.3
Elect.	(V_5)	181	184	1.7
Trade	(V_6)	484	508	5.0
Transp.	(V_7)	911	867	5.1
Serv.	(V_8)	1,790	1,799	0.6
White wages (W_1)		2,699	2,732	1.2
Non-white wages (W_2)		1,318	1,248	5.6
Non-wage Income (N)		2,242	2,293	2.3
White employment ($\sum\sum_{oj} L_{1oj}$)[c]		1,190	1,190	-
Non-white employment ($\sum\sum_{oj} L_{2oj}$)		6,130	5,569	10.1

[a] Values in R millions, employment in thousands of workers.

[b] Percentage difference calculated with the smaller in the denominator.

[c] White full employment is achieved in both simulations.

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Reforming Grain Marketing Systems in West Africa:

by

Elliot Berg

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

Discussion Paper 79

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Reforming Grain Marketing Systems in West Africa:

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Elliot Berg

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This paper examines the foodgrain marketing problems of the West African Republic of Mali and analyses why numerous proposals for reform have proven infeasible or too difficult to implement. Among his principal findings are these: i) the Mali government is severely limited by physical, financial and organizational factors in what it can implement; ii) the present mixed system of marketing (government and private sector) cannot be easily patched up as recommended in some studies; iii) uncertainty over prices and general market disorganization divert farmer effort to cash crops and may reduce farmer willingness to undertake greater efforts or new ventures in grain production; iv) since existing cooperative organizations are instruments of government used mainly for grain requisition purposes, farmers are reluctant to set up true cooperatives which could better defend their interests; v) external assistance, including food aid and a line of credit in the Operations Account in Paris has diluted the impact of grain-marketing policies and allowed the Mali government to maintain policies without having to fully absorb the consequences; vi) until very recently, the government had not been presented with well-thought-through proposals. The author concludes that in any successful reform a state grain agency will have to play a major role -- even under "minimalist" assumptions about the state's role in grain marketing -- and that major improvements will result from indirect measures such as improvement and extension of feeder-road networks, better information on crops and marketing, and better dissemination of such information, closer attention to relaxing of production constraints on food grains, and improved policy analysis within government. Such indirect changes will widen the options for reform and increase the probability of their adoption.

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REFORMING GRAIN MARKETING SYSTEMS IN WEST AFRICA

A CASE STUDY OF MALI

The West African Republic of Mali may hold a record in the world of foodgrain marketing, price policy and storage: in the past five years, no fewer than eleven missions have studied Mali's problems in this area, and have written reports thereon.[1] And this is not an accident. Mali's difficulties have been and remain deep-rooted, and finding a way out is not simple. One happy result of all this attention is that Mali's grain-marketing system and price policies are unusually well documented. Since marketing and price issues are important in the country's rural development, Mali provides a highly pertinent case study. The nature of the problems -- the deficiencies of existing structures and policies -- are clearly observable, as are the obstacles to reform; and in many respects, the Mali situation has close parallels throughout West Africa. This paper focuses on the question: why has reform proven so difficult?

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[1] FAO, Rapport au Gouvernment du Mali sur le probléme de la Commercialisation des céréales (The Panhuys Report), 1973. République Française, Bureau de Développement de la Produciton Agricole (BDPA), Mission de Restructuration de l'Office de Produits Agricoles du Mali (OPAM), Mai 1975. Mission de réstructuration de l'OPAM, Ph. Richard et X. van den Berg, 1976. EDPA, Séconde mission de réstructuration de l'OPAM, 1977. République Française, BDPA, Rapport de mission relatif à la réstructuration de l'OPAM et à l'organisation du marché des céréales, Ph. Richard et J. Herpin, Novembre 1977, 2 tomes. Institute de productivité et de gestion prévisionnelle (IPGP), Rapport final de la Commission interministétielle sur la réstructuration de l'OPAM, 1976. IDET/CEGOS, Etude des structures de prix et mécanismes de la commercialisation des mils et sorgho, 1976, 3 tomes. CILSS/CLUB du SAHEL, Working Group on Marketing, Price Policy and Storage, Marketing, Price Policy and Storage of Food Grains in the Sahel - A Survey, 1977, 2 volumes. OPAM/Agroporgress, Implantation optimale des stocks, W. Sachers, 1976, 49 pp. OPAM/Agroporgress, Etude des problémes de la commercialisation du mil/sorgho pendant la campagne 1976/77 dans les régions de Sikasso, Ségou et Mopti, W. Sachers. CILSS/Club du Sahel, Etude sur le stockage des céréales dans les pays du Sahel, 1978, 2 tomes.

I. Deficiencies in Marketing Performance and Policy

There is little disagreement in most of the reports, and in the understanding of concerned Malians, about the kinds of inadequacies that characterize grain marketing performance and policies in Mali. These diagnoses have been described in detail elsewhere.[1] Here we will only summarize some of the main problems.

A. Policy Objectives Not Met

First, the present marketing policies are failures when judged by their own objectives. The main objectives of the present marketing policy, as these are conceived by Malian representatives and written in relevant documents, are first, to control (maitriser) the grain market, so that producers can be guaranteed a renumerative minimum price; secondly, to guarantee grain supplies for deficit regions, including urban areas; thirdly, to stabilize prices to both consumers and producers. Related objectives are the protection of peasants against possible exploitation by traders and the development of "orderly" trading arrangements.

It is not uncharitable to observe that none of these objectives have been achieved. As can be seen in Table I, one-half to three-quarters of the total volume of marketed millet/sorghum passes through the "traditional" sector -- i.e., private traders. In addition, the state grain trading agency, the Office des Produits Agricoles du Mali (OPAM) has not been able to maintain a floor or ceiling price on grain purchases and sales, nor has it been able to stabilize consumer or producer prices seasonally or inter-annually. Table II is indicative.[2] Moreover, OPAM does not even

---

[1] Cf. CILSS/Club du Sahel, Marketing, Price Policy and Storage of Foodgrains in the Sahel, A Survey, (CRED, University of Michigan, 1977) Vol. I, and this section on Mali in Volume II.

[2] See, for additional data on between official and actual market prices for foodgrains, CILSS/Club du Sahel, 1977, Vol. I, p. 54.

Table I - Estimated Total Marketings of Millet/Sorghum, and Amounts Marketed Through "Official" Channel, 1960-1978.

(000 tons)

	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
TOTAL MARKETINGS[1]	125	124	130	129	98	108	111	125	84	90	107	107	94	99	128	130	120	119
OFFICIAL PURCHASES[2]	20	21	29	16	17	26	57	60	8	26	12	29	11	9	40	71	n.a.	n.a.

SOURCES: CILSS/Club du Sahel, Marketing, Price Policy and Storage of Foodgrains in the Sahel, Vol. I, p. 41; FAO, Report on Cereals Policy in Mali, 1978.

[1] 15% of estimated production.

[2] After 1965, OPAM purchases.

Table II - Official and Actual Market Prices for Foodgrains (Feb. 1978)
(MF/kg)

	OFFICIAL PRICE		ACTUAL MARKET PRICE	
	Producer	Consumer	Producer	Consumer
Millet/Sorghum/Maize	36	56.50	30.50	150
Rice (Paddy Blanc)	45	-	-	-
Rice (Rm 4 0)		137.	-	300

SOURCE: FAO, 1978

supply most of the grain to deficit regions; it was estimated in the mid-70s that private traders handled 60 percent of the grain supply in the remote and particularly food-scarce Sixth Region.

The reasons for these failures to attain stated objectives are well known. OPAM's shortages of financing, storage capacity, trucks, and personnel played a part. Inflows of food aid and the demands of the 1972-74 drought led OPAM to play a major role in channeling imported grain, to the neglect of its internal marketing role. A price policy imposed on it by government (low consumer prices for millet and sorghum) reduced its liquidity, and a policy of purchases and sales at uniform national prices led to further operating deficits and a reduction in liquidity. At least up to 1976, the slowness with which the grain quotas were set and delays in release of crop-financing funds by the banking system meant that OPAM was never even present in the market until January, after the peak post-harvest marketing period was over.

Thus, OPAM and the existence of a legal monopoly has not protected the producer against presumed "exploitation," as it was designed to do. Nor has the hope that state grain marketing would impose a more orderly and efficient organization on the grain trade been borne out by experience. There is considerable uncertainty over marketing responsibility not only between public and private sectors, but within the public sector as well. For example, ambiguity over marketing jurisdiction has recently arisen between the cooperatives, OPAM and Operation Mils-Mopti, which has taken over responsibility for grain marketing in the area of its activity.[1]

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[1] A recent evaluation report comments: "After the beginning of the 1976-1977 campaign the government suddenly decided that in the Bankass and Djenné cercles the existing cooperatives would take over the grain collection and deliver directly to OPAM. It is, however, expected that this was only a temporary measure (the reason of which is not officially known) and that in the coming season Operation Mils will again be charged with commercialisation in its whole intervention area." Mahamadou Berthe and G. Olaf Meyer-Ruhle, Report on the First Joint Evaluation of Operation Mils-Mopti, Mopti/Bamako, April/May 1977, p. III-10.

B. OPAM Operating Deficits and Inefficiency

In recent years the Mali on economy has been characterized by severe budgetary and balance of payments disequilibrium. Budget deficits from 1972 to 1976 were between one-fifth and one-third of total expenditures and closer to one-third of recurrent revenues. During the same period the overall balance of payments showed large and growing deficits, amounting to between 20 and 50 percent of recorded imports.

The accumulation of debt by OPAM (and other public enterprises) was a major factor in the economic deterioration of the 1970-76 period. During these years OPAM accumulated a debt of 38 billion MF (about $80 million), 12 billion of it in 1974 alone; this was equal to 40 percent of total budgeted government expenditures during that year.

Some of this debt arose during the 1972-1974 drought, when Mali imported large amounts of grain to stave off famine. These imports were sold at heavily subsidized prices and were financed by bank credits to OPAM. But much of it arose from the too-small margins between OPAM's buying and selling prices for grain, which make it impossible for the agency to cover its marketing costs.

A significant proportion of OPAM's deficit also derives from management inefficiency, particularly with respect to transport and storage operations. Transport deficiencies commonly delay movements of grain stacked outdoors under tarpaulins, exposing it to the first rains. The CEGOS Report is only one of the many which refer to substantial losses because of poor storage management. The burden of these losses is passed on to producers and their cooperatives, removing any direct incentive for OPAM to improve its performance.[1] In other cases, grain stored indoors suffers heavy losses because of insufficient or improper fumigation, infested sacks, failure to rotate properly.

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[1] ...if not stored properly, grain delivered to OPAM deteriorates rapidly. Each year important quantities (thousands of tons) can't be carried away before the onset of the rainy season and are thus rendered unfit for consumption. The loss is absorbed by the producers, if OPAM hasn't already paid them and by the cooperatives, if OPAM's funds were distributed, since OPAM demands repayment." (IDET/CEGOS, *op. cit.*)

C. Poor Marketing Services

The private grain trading system is undeveloped. The number of individuals working exclusively as traders is very small. More important, there is extremely little specialization in foodgrains, just as there appear to be very few traders who are full-time traders and nothing else, so there are few traders who work at the grain trade alone.[1] Most buy and sell consumer goods and other crops. All this means that the distinction between producers and traders is frequently obscure, as is the distinction between traders and consumers. The person who acts as millet assembler also trades in consumer goods, in rice, in groundnuts.

In addition to small scale and lack of specialization, the grain marketing system is characterized by poorly developed rural credit arrangements. Private traders do provide some credit, but it is unclear how much. Although it is widely believed that a substantial proportion of producer millet sales are made to pay off preharvest debts, such evidence as exists suggests that this is a relatively minor factor. The IDET/CEGOS study found that in only 15 percent of the villages they surveyed did traders appear before the harvest. They report that most of the sales which occur in the villages come from reduction of stocks as the new harvest approaches. The 1973 FAO (Panhuys) Report estimated -- very roughly -- that perhaps 5,000 tons of millet/sorghum were sold to traders in debt repayment at harvest time. This would have been less than 5 percent of marketed output.

Similarly, very limited amounts of grain are stored by traders. It is rare to find private traders with a storage capacity of as much as fifty tons. Most storage, like most trading activity, is mixed -- i.e., grain and other commodities, frequently including consumer staples like sugar, will be stored in the same place, generally a room or two in a rather rudimentary building.

The private sector marketing facilities provided to sellers of foodgrains are thus very rudimentary. By comparison with what is available for export crop producers, they are glaringly deficient, since the public grain trading agencies do not provide much more. Neither public agencies nor private traders maintain an effective presence in the villages. For first echelon storage (at _cercle_ _chefs-lieux_) in the state marketing circuit, the farmer himself or the village authorities acting in the name of the village cooperative must arrange for transport of grain from farm to the _cercle_. But the "cooperatives" are paid too little by OPAM; costs of transport from village to the district (_arrondissement_) level are not fully covered. Sometimes the local cooperatives are not paid at all. Moreover, they (i.e., the farmers) must bear the costs if inadequate storage and transport delays cause losses of stored grain.[1]

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[1] The CEGOS Report states categorically: "There are no private traders in Mali who deal in millet alone: millet purchases at the farmer level and wholesale are considered by the main agents only as a supplement to marketing of other products (especially sheanuts and groundnuts)."

Illustrative of the differences in public marketing services provided for cash crops and those for food crops is the fact that the Operations will send trucks to bring groundnuts to main storage points whenever a village or group of villages can assemble eighty sacks -- and this at no cost to the producers.[2]

It is much the same with other services normally provided by a marketing system: credit, trader-provided storage capacity, off-farm inputs. Credit is available via the export crop promotion agencies, as are fertilizers and other inputs. However, with a few exceptions (e.g., the Operation Mils-Mopti), food growers must rely on "traditional" sources of credit, little of which appears to be provided by traders. And a few input-provision schemes are available, except for export crops.

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[1] IDET/CEGOS, Op. cit. In its village survey, the IDET/CEGOS team notes that in almost 40 percent of the villages, peasants "spontaneously" declared that their costs of transport of grain to the _arrondissement chef-lieux_ were not paid for. The cooperatives (Federations de Groupements Ruraux) take the rebate that OPAM gives for this purpose, to meet their own expenses. IDET/CEGOS, Op. cit., Tome III, p. 41.

[2] Center for Research on Economic Development, University of Michigan, _Mali_: _Agricultural Sector Assessment_ (Ann Arbor: December 1976) pp. 119-120.

D. Negative Production Effects

It's not possible to know the extent to which inadequacies of marketing arrangements and policies have affected grain production. Table III shows existing estimates of output trends for major crops during the past twenty years. It's clear that until 1974 foodgrain production was stagnant or declining; the same is true for groundnuts,though not for cotton. But it's impossible to sort out the effects of marketing policy, price policy, general economic policy, and weather variations. (Given the data uncertainties, it's often not even clear what has to be explained.) One must nonetheless strongly suspect -- as so many observers have -- that the uncertain, thinly structured and relatively poorly-functioning marketing set-up has had negative effects on grain output and on producer willingness to sell.

E. Negative Equity Effects

The marketing system has many inequitable features. There is, first of all, the "quota" or requisition system, by which decisions are made on the amounts of grain which villages must deliver to OPAM at official prices. In a year of poor harvests, this system requires the delivery of grain at below market prices. Those whose grain is requisitioned may have to buy for their own consumption later in the year, at free market prices.

Similarly, until very recently, OPAM has had almost no motor pool of its own. It had to rely on truckers, both public and private, who were paid according to an officially-fixed tariff structure which was generally too low to make OPAM assignments profitable. As a result, OPAM (with local administrators) regularly "requisitioned" private trucks -- i.e., forced them to carry grain at the unprofitable edicted rates. One consequence was that many transporters took their trucks into neighboring countries when the buying season began.[1]

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[1] Sidiki Tementao, Analyses due Systéme de Commercialisation des Céréales au Mali, Memoire, Ecole Nationale d'Administration, Bamako, 1977, p. 54. Tariffs have been revised upward since 1977, and OPAM has been endowed with a considerable vehicle pool of its own (some 40 trucks), the problem of transport requisition may be less substantial now. But it can be counted on to reappear as soon as prices change and/or OPAM's motor pool shrinks in size.

Table III - Production, Marketing and Official Producer Price of Principal Crops
1957-1978

	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	57/58	58/59	59/60	60/61	61/62	62/63	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78
MILLET & SORGHUM																					
Production				833	827	867	863	651	721	737	830	558	603	715	715	624	660	850	865	800	790*
Producer Price		16	11.6	10	10	10	10	11	11	15	16	16	18	18	18	20	20	32	32	32	
RICE, UNHULLED (PADDY)																					
Production				160	145	200	189	192	162	162	172	134	161	137	157	116	130	250	260	257	200
Marketing					24	28	31	27	26	32	35	26	34	40	52	47	59	84	100		
Producer Price (Paddy Blanc)		12	12	14	8	11	11.6	12.6	12.6	16	18	18	25	25	25	25	25	40	40	40	
COTTON																					
Production				9	10	18	24	31	22	32	39	50	51	59	74	72	55	71	100		
Marketing				5	6	12	16	28	18	28	33	45	45	53	68	66	51	61	90		
Producer Price (1st Quality)	34	34	34	34	34	34	34	34	34	34	40	40	45	50	50	50	50	75	75	75	
GROUNDNUTS (UNSHELLED)																					
Production				122	138	167	182	173	153	159	119	96	136	156	152	135	132	188	205		
Marketing				54	63	67	74	50	27	40	29	33	57	74	60	50	43	70	87		
Producer Price		14.8	15.8	14	14	14	14	13	13	16	24	24	30	30	30	30	30	40	40	45	

SOURCE: CILSS/Club du Sahel, Marketing, Price Policy and Storage of Food Grains in the Sahel, Vol. I, Statistical Appendix; FAO, La Politique Cerealiere au Mali, Rome, 1978, Annex 3.

*Provisional estimate.

A third form of inequity arises from OPAM's normally limited capacity to meet demands in urban areas and deficit regions. A dual market is created, since a favored group is provided with OPAM's stocks at official prices, while others buy in the free market at a much higher price. Some idea of the magnitude of the differences is given in Table II; grain purchased in the free market in early 1978 cost two or three times as much as OPAM-provided grain. The 1978 FAO Report describes the consequences as follows:

> ... When (OPAM) has insufficient stocks it reduces the quota which consumer cooperatives receive for delivery to households. These households then must buy on the free market, often at twice the prices. As for the public sector, and civil servants, the quota is generally maintained, which makes these consumers a privileged group. But they are only 2 percent of the labor force...

II. Obstacles to Reform

If it is true that most technicians would agree with the main elements of the preceding diagnosis, then the question arises: why has it proved so difficult to make appropriate changes? After all, as we noted at the outset, Mali's grain marketing and price policy arrangements have not gone unstudied, nor is there any lack of proposals for change.

A. Politics

One part of the explanation must be found in the political environment. The political factor is indeed obvious and always mentioned. The Malian political authorities have persistently hesitated to raise official foodgrain prices to urban consumers, presumably because of unwillingness to risk severe political reaction. Their perception in this matter may be right; examples of disturbances and political upheavals have in fact frequently followed efforts to eliminate food subsidies enjoyed by urban populations -- for example, in Egypt and Peru in recent years.

The political factor is clearly present and important. Two aspects of it are worth special comment. First, it is evident that reformers, particularly outsiders, tend to give less weight to the political risks of change than do the political authorities concerned. This is true even where the objective political realities are similarly perceived. But such similarity in perception is rare; reformers will naturally tend to see fewer risks than politicians.

Secondly, in Mali in particular, the authorities appear to have been especially sensitive politically, and hence especially resistant to risky policies. This is reflected in the economic policies and performance record of the past decade. Of all the francophone West African countries, Mali has had the most persistent balance of payments deficits and the most persistent budget deficits.[1] These deficits have also been the largest, relative to the size of the economies in question. In Niger and Upper Volta, countries similar to Mali in many ways, and also under military rule in the last decade, public expenditures have risen by about 6 percent a year; in Mali the rise has been about 15 percent. The major source of the budget deficit is generally said to lie in the Mali government's policy of hiring secondary school and university graduates. But such a policy does not exist in neighboring states.

The employment policy is only one of several elements suggesting that the Mali Government has tended to be more anxious than similarly placed governments to avoid imposing reductions in income and economic welfare on the bulk of its urbanized population. Its import policies in 1973 and 1974 are another indication. Mali's total tonnage of food imports (aid and purchases) was higher than any of the other drought-afflicted countries of the region; in 1974, the Mali government paid out of its own resources for 55,000 tons of rice, at a time when lower-priced coarse grains were available. Similarly, Mali was the last of the Sahel states to raise official consumer prices for foodgrains closer to world prices; it held out until early 1975 while the other governments of the region let prices rise in the fall of 1974. Similarly, Mali's wage policy response was somewhat faster and stronger than its neighbors, as Table IV shows.

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[1] Chad, in the midst of a civil war, may have had budget deficits which were as large a share of total expenditures as in Mali.

Table IV - Wage Changes by Skill Level, 1967-1975
(1967-1969 = 100)

	1970	1971	1972	1973	1974	1975[1]
Mali						
Unskilled Rate (SMIG)	100	100	100	136	193	217
Middle-level Manpower Rate[2]	100	100	100	100	111	116
University Graduate[3]	100	100	100	103	109	115
Niger						
Unskilled Rate (SMIG)	100	100	100	100	140	160
Middle-level Manpower Rate	100	100	100	100	100	112
University Graduate	100	100	100	100	100	104
Senegal						
Unskilled Rate (SMIG)	100	100	100	106	145	212
Middle-level Manpower Rate	100	100	100	100	120	136
University Graduate	100	100	100	100	109	121
Upper Volta						
Unskilled Rate (SMIG)	99	99	100	109	134	150
Middle-level Manpower Rate[4]						
Consumer Price Index, Capital City (1970=100)						
Mali[5]	100	121	130	168	194	-
Niger	100	105	115	128	137	-
Senegal	100	106	114	135	147	-
Upper Volta	100	102	99	107	116	-

SOURCE: Berg, The Recent Economic Evolution of the Sahel (CRED, 1975) pp. 118, 122

[1] January

[2] Typical rate, middle-level worker, Civil Service (except for Upper Volta, where it is private sector rate).

[3] Starting rate, University graduate (Licence), civil service.

[4] Actual rate, one employer, private sector.

[5] Foodstuffs only.

Mali's grain-marketing and price policies, then, are part of a larger pattern of economic policies which shows not only an unwillingness to risk urban political unrest but a more general unwillingness to accept tough discipline in economic management. There are many reasons for this.[1] One of the most fundamental is the existence, in the French Treasury, of the line of credit known as the Operations Account. Mali has been able to incur large budget (and balance of payments) deficits by drawing on the Operation Account. There are really two factors at work here relevant to grain marketing reform: the Malian government has been especially reluctant to impose hard choices in grain price policy, and it has been able to avoid these choices -- as it has been able to avoid or soften similar unpleasant constraints in the budget and credit areas-- by drawing on its line of credit at the Operations Account.

B. Different Donor-Recipient Perceptions

A second obstacle to reform or, more generally, to the introduction of economically efficient policies, derives from the different interests and perceptions of the parties to aid transactions. What lenders might regard as economically efficient may not be seen as such by the borrowing country.

The clearest and most relevant example is in the area of storage programs and policies. On the basis of strict cost-benefit accounting (and risk questions aside) it may be possible to demonstrate persuasively that a foreign-exchange-based food security policy, with a relatively small "first line of defense" emergency reserve, is the most cost-efficient strategy for Mali. This would involve a public, centralized storage capacity of far less than the hundreds of thousands of tons now existing or envisaged. But from the Mali government's point of view things look different. There is, first of all, the fact that the Malian authorities will see greater likelihood of famine and will weigh its impact more heavily. But aside from this, the Malians know that there are almost no opportunity costs to aid funds available for grain storage facilities. From the local point of view, only if discounted future local costs of silo maintenance and operation exceed discounted benefits will it be advisable to adopt an "objectively determined" cost-effective solution.

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[1] See E. Berg, The Recent Economic Evolution of the Sahel, 1975, Center for Research on Economic Development, University of Michigan, Ann Arbor.

In these circumstances, it is not surprising that large increases in storage capacity have occurred or are under consideration not only in Mali but throughout the drought-prone Sahel; and this despite the generally shaky analytic and technical support for the storage strategies implied. It's not hard to see why local perceptions and local interests tend to prevail in this area. Silo construction is relatively cheap; silos are attractive to donors because of their visibility and their apparent contribution to a politically attractive goal; they can conceivably bring dramatic benefits in time of catastrophe; and there are many competitive donors anxious to help in food security matters.

C. Underestimate of Present Defects

Many Malian officials and other observers are fully aware of the deficiencies of the marketing sy[illegible] as outlined earlier. The public position most often expressed b[illegible]ponsible local officials is to recognize these problems, and to suggest that the reasons for them lie not in the structure of the situation but are rather due to OPAM's lack of resources and experience. They point out that OPAM is, and has always been, short of credit for financing crop purchases, short of trained staff, without its own transport facilities, and with only limited storage capacities. They also point out that the extraordinary demands of the drought years made it impossible for OPAM to meet its marketing/price policy objectives, and that indeed OPAM's operational life has been too short for any meaningful evaluation.

Because this general issue is so central to the understanding of marketing/price policy questions and to the problem of reform, it is important to address it directly and at some length. The defects of the marketing system are in fact structural in nature, not incidental or transient. The present system[1] contains a number of basic contradictions, major flaws which cannot be eliminated except by transformation of its essential characteristics.

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[1] The "present system" has the following central features: partial, fictional state monopoly of the grain trade; purchase of part of the crop at fixed prices by imposition of quotes; sale of publicly purchased grain mainly in cities and other deficit zones; use of price averages ("perequation") such that official producer prices are uniform nationally, and official consumer prices are similarly everywhere uniform.

1. Difficulties of Peaceful Public-Private Sector Coexistence

First, the peaceful coexistence of public and private sectors in the grain trade requires that prices be the same in both sectors. If not, grain sales will tend to flow to one or the other sector, depending on size, as is presently the case. As things now work, if the official producer price is above the market-determined price, farmers will sell to OPAM, if they can. Thus, in years of bountiful harvest, OPAM can buy all the grain it wants, or for which it has financing and storage capacity. In lean years, it can buy little. This tendency can be clearly seen in OPAM's pattern of purchases in recent years: it is able to buy in insignificant quantities in a year of poor harvest and high market prices; peak purchases are almost always made during the bumper crop year.

This all-or-nothing tendency can be avoided only in one of two ways. One is for the government to abandon any positive price policy. The government's official producer price would be the same as or close to actual free market prices. This presents an obvious inconvenience: it means abandonment of a primary raison d'être of the state trading system itself. The second solution is to make available the financial resources and storage capacity required to implement a true price stabilization effort. OPAM could then buy for a buffer stock in good years and sell in lean years. Intra-annually, similarly, OPAM would support grain prices near their desired level by buying during the postharvest period and selling during the soudure. The question is; to what extent is such stabilization feasible and desirable?

The question of stabilization will be taken up later, but here it can be noted that inter-annual price stabilization is certain to be very expensive in Malian conditions because of (i) wide swings in rainfall, output and especially in marketed supply; (ii) a possible tendency for farmers to substitute public storage for some village-level private storage; (iii) risks of heavy storage losses. Its desirability is also open to question on the grounds that if successful, it could destabilize producer incomes from foodgrain sales, a result which may not be in line with public policy objectives. Most important, if price stability encourages production of foodgrains for the market, and/or if -- as is likely --

the stabilized price is higher than the average market-determined price,[1] then additional marketed supply might be called forth in volumes burdensome to the economy.

Just as price differentials create awkward conditions on the producer side, so do they create problems on the consumer side. Whenever prevailing market prices at the retail level are higher than official retail prices, farmers, traders and some consumers have strong incentives to bypass the state structure and deal with each other directly.

The existence of a private trading sector imposes restraints also on another basic aspect of state grain price policy: the principle of uniform grain prices over the whole national territory. This "perequation" principle can be pursued by OPAM without involving losses (deficits) only if losses incurred by OPAM activities in areas where marketing costs exceed the average are balanced by profits from purchases and sales in markets of easy access (hence lower then average) costs. But in a system of coexisting public and private trading sectors, the private traders occupy the profitable markets and leave the unprofitable ones to the state agency. The traders buy where and when producers offer grain for sale at relatively low prices -- i.e., in the more productive regions, and those served by better roads, at harvest time. They sell, similarly, in the most attractive markets (especially Bamako and the other towns) where unit marketing costs are relatively low. OPAM is constrained to buy and sell everywhere, and at the uniform national prices. Under the circumstance, there is no way OPAM could avoid deficits; if its buying and selling prices were fixed at levels reflecting true average costs, the result would be to abandon the market to the private sector. Or, of course, uniform national pricing would have to be abandoned.[2]

A related problem has to do with smuggling. So long as private traders are allowed to operate, and a policy of uniform national pricing continues, there will be a strong tendency for grain to move over frontiers. Only if the government could effectively impose an export monopoly (or assure harmonized pricing policies around frontiers) could extensive smuggling be avoided. This, incidentally, provides additional incentive to seek alternative means of meeting the government's regional equity objectives, to the extent that such goals are of high and continuing priority.

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[1] i.e., that the price-stabilization scheme is not a "pure" stabilization effort, but has price-raising intent.

[2] Some other means might be sought to implement the government's objective of favoring remote and uncongenial regions. Grain transport costs, or all transport costs, could be directly subsidized; civil servants (and other wage earners) could be given a salary supplement, etc.

Another fundamental problem in the mixed trading system has to do with price and quality differentiation. The state trading sector cannot effectively compete with the private traders unless it sets down a much more refined price structure than now exists. At present, extremely little differentiation exists. OPAM offers the same price for millet, sorghum and maize. Prices are the same for different kinds of millet and sorghum (e.g., white millet and red millet). Buying and selling prices do not differ with respect to the quality of millet and sorghum.

The more egregious aspects of this homogeneity could presumably be dealt with relatively easily -- i.e., different prices for millet, sorghum, and maize. But even here, delicate decisions might be required, and wrong decisions could lead to serious distortions. What should be the relative prices of maize and sorghum, red millet and white millet? Demand conditions vary from region to region and year to year, as do supply conditions, due to rainfall variations. Unless it reproduces the private sector price structure, OPAM risks finding itself with unwanted surplus stocks of some grains and recurring shortages of others. Or, if OPAM enforces a price structure on the private sector it could give wrong signals to producers -- e.g., as at present, paying "too much" for sorghum relative to millet and making sorghum more profitable to produce,even though it may be relatively less desired by consumers.

Quality differentiation poses even more problems. Under the present system, OPAM gets the worst quality grains, since it pays the same price regardless of quality. For OPAM to try to reproduce the rich variety of quality and price differentials that typify even the most isolated rural market is almost unthinkable. It would require enormous manpower and surveillance and would involve so much bureaucratic discretion as to invite extensive abuse, particularly if used in conjunction with the quota system for requisitioning grain. In the long run, farmers would only sell to OPAM if the quality gradings and price differentials available there were as favorable as in the private market.

2. Difficulties and Injustices in Primary Marketing

The organization of the state sectors crop purchase is extremely cumbersome. The system works as follows. Crop size is estimated in every village in July. These estimates are sent to the *Commandant de Cercle*, who - advised by a cereals committee - transmits these estimates to the Governor of the region. The Governor sends the estimates to the Ministry of Interior, which then determines the quota of grain which will be required of each district (*arrondissement*). This *arrondissement* estimate is taken as a quota which the administrative head of the *arrondissement* must deliver to OPAM at the *cercle* headquarters, whence it is stored or shipped to deficit regions.

At every step of the way, their arrangements give rise to grave problems and potential abuses.

a) In July the villagers have only a very rough idea of the size of the coming harvest. They have, in any case, every incentive to understate their estimate. The *arrondissement* head also tends to make minimal estimates, so as to reduce his risks of non-performance. The *encadreurs* have an interest in overestimating production, however.[1]

b) The primary marketing is traditionally the responsibility of the cooperative organizations, the *groupements ruraux*. But these are administrative units. Membership is obligatory. The executive committee of the "cooperative" is frequently the village council. The Federation des Groupements Ruraux is chaired by the regional administrative head. In general, then, there is no arms-length relationship between "the administration" and the "cooperatives". So the whole process of quota determination tends to set farmers against the government. When the quotas cannot be met, force is used - "arguments of authority" as the IDET/CEGOS Report puts it.

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[1] Hans Guggenheim points out the tendency for young *encadreurs* "to feel that their pride is involved in producing high yield figures and in commercializing as much as possible". (H. Guggenheim, *Traditional and Modern Techniques in Grain Storage and Transportation: Problems and Solutions for operation Mils-Mopti*, Report to AID/Bamako, Jan. 1977, p.12). He also mentions one village where the quota one year was 40 tons, and the commandant asked for 400 tons the next year. The quota was finally fixed at 160 tons. Given the lack of knowledge of yields and output, it is easy to see how such problems could arise.

c) The system of previsions is often not completed until December, but this is too late for OPAM to take account of the estimates in its financing request to the Malian Development Bank. So the credit allocation to OPAM is not only based on uncertain crop size estimates, but very late as well. This seems to be the main reason why, in most years, OPAM has been unable to enter the market immediately at or near harvest time (September-November), when sales are at their peak.

d) The "cooperatives" (i.e., the farmers themselves) are responsible for transporting their quotas from their fields to the cercle, where OPAM's responsibility begins.[1] At best, the payment made by OPAM for this service is (or has been) below costs: in fact, very often the FGR keeps the OPAM transport rebate (frais de collect) "with or without the agreement of the producer".[2]

e) The FGR has to rely on private transport. Until 1978, the official tariff was too low to induce truckers to carry grain, given the lack of back-haul cargo, long waiting times, bad roads etc. So the truckers have been frequently "requisitioned" - i.e. forced to carry grain. As noted earlier, this leads some transporters to take their trucks out of the country at harvest time, thereby accentuating the shortage of transport.

f) Organizing the primary marketing and seeing to transport and storage involves senior administrative officials in the demanding and complex business of the grain trade. The radios and trucks of the prefects and commandants de cercles are mobilized in the annual effort to coordinate truck movements. The administrative officials can force truckers to take assignments. Many missteps inevitably occur: in one area trucks may be sent for a delivery which is too small. Elsewhere, not enough transport is made available, so the grain stock cannot be picked up before the rains begin.

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[1] The groupement rural (village) takes it to the district (arrondissement) headquarters, the Federation des Groupements Ruraux takes it from there to the cercle.

[2] IDET/CEGOS Report, Vol. II.

g) On the consumer side there are further anomalies, at least as of 1977.[1] The "cooperatives", in addition to purchasing and transporting the crop, are responsible for sales to rural consumers. In theory they buy millet and sorghum from OPAM's warehouse at the cercle chef-lieu. They sell it to their constituents with a legally prescribed mark-up, an amount generally insufficient to cover the costs of moving the grain by truck from cercle to arrondissement. What is especially striking is that the cooperatives can't keep grain themselves, for sale to their members, because of OPAM's legal monopoly. They must sell grain at OPAM's retail price. The farmers thus are given no incentive in the official marketing system to store grain through their cooperatives. Nor do they have any incentive to utilize the official marketing chain. They buy and sell on the "traditional" (i.e., private) market.[2]

3. Distributional Inequities

These have already been described. It is the difficulty of avoiding them which is stressed here. So long as the state sector is responsible for only a portion of the crop, and there persists a dual price structure, benefits and costs of the system will be unequally distributed. In bad years, losses will be suffered by those producers forced to sell to OPAM at the lower-than-market price. In good years, producer benefits will go to those who sell to OPAM at the higher-than-market price. Comparable inequities exist on the consumer side. Under the present arrangements the benefits of low offical retail prices go to the relatively well-off civil servants who tend to be fully provided by OPAM at the official price; others often have to pay two or three times as much as the free market. These perverse distributional effects could conceivably be reduced, and distribution of low-priced grain effected by such methods as "fair price shops" for low income people, but such finely-tuned distributional efforts are extremely burdensome administratively. How the distributional problems on the producer side could be handled is not obvious. Using higher-than-market purchase prices as an instrument of income distribution policy would demand great administrative and organizational inputs, might have undesirable incentive effects and might not be feasible anyway. It would certainly open up very substantial opportunities for administrative discretion and corruption.

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[1] Recommendations for change have been made, but it's not known whether they have been adopted.

[2] The IDET/CEGOS Report summarizes the situation this way: "Thus producers pay for this service (the storage of millet) which is performed by their own organization, and pay at a much higher price than it costs, and they pay to an organization which doesn't give the service (OPAM). The result is that when producers need millet, they trade with other producers in traditional markets..." (Vol. II.).

4. The Worst of Both Worlds

As we have seen, the present trading system poorly provides the services producers seek in a trading system -- protection against monopsony, access to credit, transport, storage, and market information. Competition among buyers, stimulated by free entry into trade, is not legally encouraged or even allowed, but no stable and effective state-provided alternatives exist. One of the main justifications for public intervention in marketing is the presumed inequality of bargaining power of the peasant vis-à-vis the trader, but the present arrangements do not balance the bargaining situation. A relatively small share of marketed output is bought at the official price by the grain agencies. The bulk of primary marketing is still in the hands of private traders. Given the risks and uncertainties of the legal situation, there are fewer traders than there would otherwise be, and the price demanded by traders for their services is probably higher than it would otherwise be.

From a longer-term and development point of view, the present arrangements do not encourage -- perhaps do not even allow -- the strengthening of private marketing skills. Their ambiguity discourages technical progress in trading practices and techniques, the growth of trading capital, and the emergence of more complex entrepreneurial skills.

D. Conflict Between Private Trader Efficiency and Doctrinal Factors

The fact that the mixed system has grave disadvantages while the preconditions for an acceptable coexistence between public and private trading sectors are so demanding, means that drastic modifications are called for if marketing deficiencies are to be effectively addressed. And this is where the fundamental problem for reformers emerges , for there are only two ways to go -- toward liberalization of the trading system (i.e., a greater role for private traders),or toward more thorough state control. And while the technical or economic advantages are overwhelmingly on the side of liberalization, doctrinal or ideological predispositions call for strengthening the state trading monopoly.

There can be little doubt about the substantial economic advantages of a private trading system as compared to a state grain trading monopoly.

a) The private or "traditional" grain trade uses resources more efficiently than state trading agencies. The supply of traders' services is highly elastic at relatively low levels of remuneration. Private trade is, for many thousands of Malians, a part-time activity. Farmers, urban workers, school children, women, all may do a little grain trading. They tend to do so in slack periods of the year. They also trade in connection with local market activities which have a social component. In such circumstances, the opportunity costs of engaging in trade are very low. It is the same with casual or informal traders -- chauffeurs and others with command over empty cargo space. These traders' services are offered in relative abundance and at low cost.

Even those who are full-time traders do not deal in grain alone. The volume of trading activity and the rate of return from grain trading seem too low to encourage specialization. Thus, costs of trading operations are shared by general trade -- in cash crops and consumer goods, as well as in foodgrains.

Since foodgrains are heavy in weight relative to their value, transport costs are critical, and it is in the transport area that the private trade has particularly large cost advantages. First, some considerable part of the privately-sold grain is brought directly to local periodic markets by the farmer or a member of his household. Secondly, some grain is moved between local and regional or national markets by the informal trader mentioned above. Most important, the specialized state grain trading agency normally faces fearsome cost problems because of lack of return cargo.

Especially in the remote regions, there is little cargo brought by truckers carrying grain from local chefs-lieux or wherever the primary bulking point is located. The private trade is much more economical in its use of transport -- for example, by search for two-way cargo, bulking delays, mixture of cargo, etc. What is true of transport is true of other inputs. The traditional trade in general uses human and physical capital more efficiently then the public trading structure. The latter requires formally trained manpower -- managers, accountants, clerks -- whereas the traditional trade relies on human energy and skills developed informally in the market place. Because it tends to be of larger scale and more complex, the state structure requires physical facilities -- offices, warehouses, trucks, cars, etc. -- which are more modestly provided in the traditional trade. It also requires inputs which are more scarce than physical and human capital: coordination, organizational capacity and information. A decentralized private trading system economizes on all these.

b) There are many well-known, general reasons why small organizations or private individuals tend to be more efficient than larger organizations, expecially state organizations: speed and flexibility in making decisions; freedom to hire, dismiss and reward; detailed and specialized knowledge of the activity in question; the stronger spur of material incentives. Many aspects of the grain trade do not lend themselves easily to large-scale operations.[1] To illustrate, one need only consider the probable difference between public and private responses to a situation of deteriorating grain stocks in a warehouse. The private trader would surely be more likely than a public servant to prevent infestations or improper rotation, find out more quickly if infestation existed, respond more quickly and appropriately (e.g., by forced sale at the best price). On the state side, incentives and capacities to prevent infestation are limited by personnel and budget constraints. The flow of knowledge to managers is slow and uncertain. The capacity to respond to unforeseen local situations is limited by poor communications, lengthy administrative procedures and diffusion of responsibility.

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[1] This is to say that marketing activities which benefit from significant economies of scale in the circumstances of semi-arid West Africa are substantially outweighed by activities characterized by the quick onset of scale diseconomies.

But it is perhaps less the advantages of the free market solution than the disadvantages of the monopoly solution which provide the strongest arguments for liberalization.

a) Foodgrain market structures do not lend themselves to state monopolization. Grain is grown over much of the country. It is traded in thousands of villages and hundreds of rural periodic markets. As a result of tens of thousands of small transactions, the bulking function is performed: small traders put together marketed supply virtually bag by bag. The distinction between traders and farmers or consumers is generally fuzzy, and the informal or casual traders, who utilize transport capacity for small adventures into grain trading, play an important role. Moreover, Mali has thousands of kilometers of virtually open frontiers, with ready buyers on the other side. And for food crops there is an alternative not open with many export crops: increased storage or consumption.

b) Complications related to price policy arise in a monopoly situation. In a year of bad rains and short crops, cereals prices in intra-village transactions will tend to be higher than the state agency's price, as they will be in any permitted grain transactions. (Prices may also be higher in neighboring countries.) Farmers may, therefore, prefer: (i) to store more grain; or (ii) to sell only at higher than official prices (i.e., in a parallel market). It would presumably be necessary to extend the system of quotas, requiring delivery of all marketed grain to the state at official prices, with the implications of cost and coercion implicit in all such policies. Rigid controls over grain shipments would be required.

c) Imposition of an effective monopoly would require an agent of primary marketing to replace the traders who presently handle two-thirds of the marketed crop in most years. The prime candidates for primary marketing would be the cooperatives. But, as already stated, these are virtually non-existent in Mali, as autonomous producer organizations. They lack structure, money, trained staff warehouses, and transport. To give such embryonic organizations the task of primary marketing of foodgrains would overwhelm them.[1]

Because of the weakness of the cooperatives, proposals for fuller monopolization of the grain trade in Mali frequently recommend use of the opérations de développement, the regional development agencies which provide extension and other assistance to farmers on given crops in given regions of the country -- the Opération d'Arachides et de Cultures Vivrières (OACV) for example, or the Opération Mils-Mopti.

The regional development organizations have the technical capacity and administrative structure that is frequently lacking among the cooperative organizations. They also have marketing experience, since many of them are responsible for marketing the cash crops which are their major focus. Frequently, they have a large number of buying points and substantial transport capacity. They are, therefore, possible candidates for taking on the task of primary marketing.

Were they to do so, however, severe problems can be anticipated: the development agencies have shown themselves capable of attracting considerable resources from aid donors, and this explains their relatively strong administrative and financial position. Their success in attracting assistance has also allowed them to operate with relative autonomy. It has allowed them to attract and hold capable staff, by payment of better remuneration (especially fringe benefits) than is available in the Civil Service. The access to technical assistance in some cases has also helped. Also, access to non-budgetary funding has allowed these agencies financial flexibility beyond what is usual in the public sector.

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[1] A recent FAO paper comments as follows:

> ...cooperatives as forces for the encouragement of rural development, while offering such promise, tend to disappoint and too much must not be expected of them. Given good management and a clearly defined and limited role they can perform well...When they are allocated too many responsibilities they tend to sink beneath the burden...

FAO Agricultural Services Division, "The Catalytic Role of Various Types of Marketing Enterprises in Stimulating the Expansion of Local Production", paper presented at OECD/FAO International Seminar on Critical Issues on Food Marketing Systems in Developing Countries, Paris, 18-22 October 1976.

Despite their strengths, then, the opérations are vulnerable. It remains unclear how they will find internal sources of self-financing on a long-term basis. Their work of agricultural extension, combined with other activities that nowadays make up "integrated rural development", thus has a certain urgency. The hope must be that whatever happens in the decades ahead, the efforts of the development agencies will bring about irreversible and self-sustaining changes in agricultural practices in the direction of modernization and improved productivity.

The basic task of these agencies is the stimulation of production, providing the rural population with trained cadres, introducing new methods, more and better education, more and better equipment. The production task alone makes enormous demands on available resources in money and manpower. It might be imprudent to further burden these agencies with the marketing function.

This is especially so since past experience attests to the existence of price-making priorities which strongly tend to favor low consumer prices. A policy of low consumer prices for foodgrains, combined with high costs of marketing, can be expected to put pressure on the primary marketing agents, who may find that marketing of foodgrain is costing them more than they are being paid by the other agents further along in the distribution chain.

This has been the experience in Opération Mils-Mopti. The OMM buys the grain from farmers and transports it to OPAM storage depots in arrondissement-level chefs-lieux. The following quotations indicate the kinds of diversions and problems which have arisen:[1]

> OPAM is supposed to receive the cereals at the chef-lieux of the arrondissements, OMM being responsible for the transport from the collection points to the chef-lieux. However, since OPAM does not dispose of agents and storage facilities in most of those places and of sufficient (owned) or contracted) transport capacity the rule is that OPAM receives the merchandise only in the capitals of the cercles, thus increasing the transport volume of OMM.

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[1] Mahamadou Berthe and G. Olaf Meyer-Ruhle, Report on the First Joint Evaluation of Mils-Mopti, Mopti/Bamako, April/May 1977.

There are major difficulties in handling the grain after delivery by the farmers:

- -insufficient transport facilities to meet the increased transport requirements,
- -no storage facilities at the collection points (whenever OMM disposes of storage capacity - thought for storage of production inputs - it is used to the possible extent for temporary grain storage).
- -delays in discharge and weighing at the OPAM reception points in the peak season (at the end of the campaign).

These shortcomings are causing losses of grain because of open-air storage with serious damages when evaluation is delayed beyond the start of the rainy season. Last year, OMM was involved in grain transport until the month of August which considerably affected their extension activities for the new season. However, since damages and losses are at the risk of OMM until the grain is handed over to OPAM, evacuation of the cereals constitutes a priority activity to the Opération.

OMM tries to recuperate sacks and money from farmers who have not delivered the envisaged quantities. Sometimes one or both of them cannot be recuperated. Figures of those losses were not available.

This suggests a final consideration: the impact on farmers. Grain marketing is full of uncertainties. Transfers of funds to finance crop purchases can be delayed or reduced. Transport, storage advances of credit for purchase of inputs -- all can create the kinds of pressures indicated in the OMM case. Good rains can create a tremendous disposable surplus which cannot be marketed at announced official prices or transported and stored appropriately. Bad harvests will unloose producer pressures to sell on parallel markets for higher than official prices. Unless an effective price policy is introduced, these price problems will be inevitable.

The involvement of the development agencies in primary cereals marketing thus sets loose a whole array of potential conflicts -- or at least adversary relationships -- between the development organization and its clients, the rural producers. There are high risks that resulting distrust could affect peasant attitudes toward the development agency, its personnel, its productionist efforts.

For all these reasons, it would seem highly undesirable to give the Opérations full, or even major, responsibility for grain marketing. But other alternatives are either not feasible or scarcely more desirable. The absence of a suitable substitute for the private trader in primary marketing is a major constraint on state monopolization.

The present mixed arrangements, then, are disadvantageous from the point of view of both economic growth and social equity. They also have many elements of built-in instability. At the same time, introduction of more extensive state monopoly is inappropriate to the structure of grain marketing and certain to bring on heavy social, economic, and administrative dislocations. The conclusion would seem inescapable: private trade in grain should be legalized and private traders allowed, even encouraged, to perform marketing services.

The trouble, of course, is that this simple yet compelling conclusion runs up against deeply-held ideological convictions.

In Mali, as in so much of the world, there exists among urban people, civil servants, and intellectuals a widely shared vision or model of farmer behavior and rural market performance. The majority of farmers are beieved to have intense demands for money income at harvest time to pay taxes and debts, meet the costs of marriages, and postharvest ceremonies and celebrations. They meet their demands for cash by selling part of their grain crop, but they sell it in the immediate postharvest period when prices are at their lowest. They buy back grain later in the year when prices are at their peak. Farmers are believed to be widely indebted to traders, who demand repayment at harvest time, paying the farmer extremely low prices -- i.e., exacting a very high real rate of interest.

All of this occurs, according to this view, in rural grain markets where the winds of competition are notably absent. Traders conspire to keep buying prices low. They easily and invariably exploit the peasant, who is seen in this view as isolated, lacking information, without alternatives, and denuded of means to [illegible].

The belief that grain markets work this way is extremely widespread, in Mali as elsewhere.[1] However, there exist very few empirical studies which confirm this belief. The number of careful studies of the structure and functioning of grain markets is extraordinarily small, even in places like India where these questions have been the subject of heated controversy for decades.[2] One experienced observer's comment -- referring to South Asia a decade ago -- is still applicable generally.

> Much of what passes as analysis in the marketing literature represents little more than a repetition of the conventional wisdom regarding middlemen behavior with little or no empirical content...[3]

This sparsity of empirical studies supporting the model of the trader-entrapped peasant and the monopsonized market is certainly true of Mali.

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[1] Cf. United Nations, Economic Commission for Asia and the Pacific, "Problems of Marketing of Small Farmers in the ESCAP Region," Economic Bulletin for Asia and the Pacific, Vol. XXVI, no. 2-3. September-December 1975. p. 2.

> The stereotype of indigenous marketing systems for the small farmer is that it is exploitive, collusive, economically inefficient and operating with high profit margins for the trader. At the bottom is the small farmer, poor, often illiterate and unorganized, whose small volume of business is of poor quality, unstandardized, costly to handle and relatively unimportant to the trader. The general poverty of the small farmers and their chronic indebtedness to money lenders, who are often the traders who buy their produce, weaken the farmer's bargaining power, especially at harvest time. This weakness is aggravated by the farmers' lack of knowledge about prices and alternative marketing procedures...The inherent weakness of the small farmer means that he is an easy target for exploitation -- underweighing or under-assessment of the produce, charging high interest rates, etc...

[2] See Uma Lele, The Marketing of Food Grain in India, Cornell University Press, 1971. See also, G.R. Spinks, "Myths about Agricultural Marketing," Monthly Bulletin of Agricultural Economics and Statistics, Vol. 19, No. 1, Jan. 1970.

[3] Vernon Ruttan, "Agricultural Product and Factor Markets in Southeast Asia," Agricultural Cooperatives and Markets in Developing Countries. D. K. R. Anschel, R. H. Brannon and E. D. Smith, editors. New York: Praeger, 1969, p. 83.

To my knowledge, there are no studies which discuss more than casually the functioning of Malian grain markets. The CEGOS study, on unclear evidence, claimed that in 50 percent of the villages surveyed, some part of marketed cereals output was sold sur pied ("on the stalk"). But they also assert that most of the sales which took place in the villages came from stocks which were sold off as the harvest approached.[1]

It is no exaggeration to say that the "monopsonized market" model is at best unproved, at worst pure myth. Nor is it unfair to observe that it is a priori dubious, given the structural characteristics of grain markets in the country.

There exists an alternative model, a different way to see farmer behavior and market performance. The "average" peasant, in this view, reflects in his behavior hundreds of years of cultural experience and social adaptation. He plants as much grain as he will need to feed his household on the assumption of normal rains, with some safety margin. He maintains, at the village or household level, a storage capacity equal to at least one year's consumption, and perhaps two years, in order to protect himself against the bad rains he knows will come periodically. He knows very well that he will need cash income at the time of the harvest. He prepares for it during the dry season - by migrating or engaging in some local income-earning activity. He prepares for it also in his production decisions -- by growing cash crops, for example. He is perfectly aware that grain prices will be lowest at harvest time and highest during the soudure, and tries to arrange his purchase, sale and storage decisions accordingly.

According to this way of looking at things, similarly, the grain market is characterized by reasonably effective competition. Entry is easy.

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[1] IDET/CEGOS. Op. cit., Tome III. Panhuys mentions a Malian trading circuit of what he calls a "usurious" type, on which debts are reimbursed in kind at harvest time. Typically, he notes, 1000 MF were borrowed, and 100 kg/ of millet were given as repayment at harvest time. (This refers to the early 1970's). He estimated that perhaps 5,000 tons entered the market this way -- less than 5% of total marketed millet/sorghum. (FAO, Rapport au Gouvemment de Mali sur la Commercialisation des céreales ("The Panhuys Report), Rome, 1973, p. 12.

Anyone can become a petty trader; little is required in terms of capital or skill. Since incomes available in other rural occupations are relatively low, the elasticity of supply of traders' services is surely very high. Even the most isolated farmer need not sell his grain at an unsatisfactory price; all he has to do is journey to the nearest periodic market to sell it there, either selling it himself or giving it to a small trader to be sold. In the rural markets, there are always passers-by who act as casual traders, civil servants, bus drivers, truckers, others who are anxious to fill empty cargo space with grain to sell in the larger towns and whose presence gives a strong presumption of competition on the buying side, a presumption which would exist anyway because of the large number of traders in the market.

This second model of a calculating peasant and a competitive market is, of course, congenial to the preconceptions of many economists. But it is more than that. It also seems to fit well with what has been discovered by a number of recent studies in countries with socioeconomic and ecological structures similar to Mali.[1]

But, in the present context, the point is not the truth or falsity of these ideas; it is rather that the "exploited peasant/collusive market" model is the way most policy-makers in Mali see the world, and it creates an unwillingness to move the marketing system more openly and more fully into reliance on private trade.

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[1] Especially the important study of Henry M. Hays, Jr. The Marketing and Storage of Food Grains in Northern Nigeria, Samaru Miscellaneous Paper p. 50, 1975. See also, P. H. Giles, Storage of Cereals by Farmers in Northern Nigeria, Samaru Research Bulletin No. 42, Institute for Agricultural Research, Ahmadu Bello University (Nigeria), 1965; W. O. Jones, op. cit., and the studies on which it is based, particularly, E. Gilbert, Marketing of Staple Foods in Northern Nigeria: A Study of the Staple Food Marketing Systems Serving Kano City, Ph.D. Dissertation, Stanford University, 1969. The operation of cowpea markets in northern Nigeria is the subject of a recent thesis, which did intensive analysis of price behavior, marketing margins, storage, etc. Like the Hays study, the study concludes that there is "no evidence of monopolistic or large scale exploitative practices". Nathaniel Omatai Okiloko Ejiga, Economic Analysis of Storage, Distribution and Consumption of Cowpeas in Northern Nigeria, Ph.D. thesis, Cornell University, 1977.

E. Poor Reform - Mongering

The policy analyses done for and/or by the Malian Government contain numerous proposals for marketing reform. All of these have, however, had serious ambiguities or flaws which have reduced their relevance and suitability. One set of proposals suffers from narrowness of focus; these can be called the "improvement" proposals. A second set of proposals for fuller state monopolization leaves unanswered many fundamental questions, which render it inapplicable. The most recent reform proposal, involving greater liberalization, is more fully developed than previous analyses, but also has questionable aspects.

1. "Improvements"

These aim at improvement of the present arrangements, without raising fundamental questions about the allocation of marketing responsibility between state and private sectors of the scope of price policy. An unfriendly critic might call these "band-aid" proposals. They focus on specific and immediate problem areas, not the system as a whole.

One example is the 1973 FAO Report (the Panhuys Report).[1] Although quite far-reaching in its discussion of the marketing system and its deficiencies, and generally perceptive in its diagnosis, the principal proposed change in this report is that official grain prices be raised by a specific amount.

A more striking example is the 1975 report of the Paris-based Bureau de la Production Agricole: Mission de Restructuration de l'Office des Produits Agricoles du Mali (OPAM), done under the auspices of the French Ministry of Cooperation. This document analyzes the structure and functioning of OPAM and concentrates on internal administrative factors which contribute to its inefficiency. Although there is considerable discussion of OPAM's "relationship to its external environment", no questions are raised about the terms of coexistence of the private sector nor about the nature and limits of price policies. The drafters of this report explicitly reject structural changes relating to OPAM's role:[1]

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[1] FAO, Rapport au Gouvernment du Mali sur le problème de commercialisation des Céréales, Rome, 1973.

> It should be noted that some people we talked to urged that OPAM's role be more limited, more oriented toward imports, storage and the supply of towns and grain-deficit regions, leaving buying responsibility to the opérations in millet, maize, rice groundnuts and cotton and sales to other, better-adapted organizations.
>
> In addition to the fact that this proposal would lead to a considerable reduction in (OPAM's) monopoly status, it is not clear that overall efficiency would be improved by allocating (grain purchase transport/storage and sale)...to three different institutions.

2. Fuller State Monopolization

The second category of reform proposals recognizes the elements of basic instability now existing. The proposals address this problem directly, by suggesting a strengthening of the state monopoly. This was the principal recommendation of the 1976 CEGOS study which was financed by the World Bank and which was intended to be a comprehensive, if not definitive study of the problem.[2]

The CEGOS Report provides much useful material on how the marketing system works and is unsparing in describing its deficiencies. The report makes recommendations on a broad front. It urges that producer prices be increased, that quality grading be introduced, that marketing margins be increased and the barèmes be made more realistic, that peasants be allowed to repurchase grain from OPAM at a price closer to the producer price. A series of recommendations are also devoted to improvement of OPAM's administrative and financial situation: that OPAM's debts be lightened, that it be given adaquate working capital, that the banking system release credit for crop purchase earlier and more flexibly, that OPAM's grain storage capacity be increased, and that a drought reserve stock of 60,000 tons be established.

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[1] BDPA, 1975, p. 68

[2] IDET/CEGOS, op. cit., 3 tomes.

Most of these recommendations, and others not mentioned, were addressed to real problems and are generally acceptable, but the major structural proposals that raise questions.

First of all, the report recommends exclusion of private traders from the primary marketing and the wholesaling of foodgrains; the traders would be restricted to retailing. No real justification is presented; in fact, the report gives limited attention to the question of market structure. It asserts in passing that grain markets are monopsonized. Thus, in discussing farmer revenues from grain production, it states:

> ...when crops are short, (farmer) incomes are cut due to the shrinkage of marketed volume...; the rise of prices on the parallel market does not re-establish the level of income from food crops because only a small part of the increased retail price is transmitted to farmers, because of agreements among traders.[1]

The considerable problems implicit in this proposal are very summarily treated. The role of primary marketing is given to the FGRs (the "cooperatives"), whose non-operational character the report elsewhere recognizes. The FGRs lack staff, structure, experience, resources, even autonomy from the administration. Yet the CEGOS report proposed they be given trucks and other equipment and a full monopoly over purchase of the grain crop. The private transport of grain from surplus to deficit regions would be prohibited by this proposal, but only a line or two is devoted to the administrative implications and none to the economic implications. Finally, even the restricted role left to the private sector is, it turns out, quite untenable. This extraordinary admission is worth citing in full:

> The control of the leading retail trade would consist essentially of making sure that traders sell at official prices and that they sell "OPAM

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[1] It should be noted that no reference to such price agreements are are found elsewhere in this report, nor are any other studies cited as evidence.

> brand" grain. The system would only permit the escape outside the OPAM circuit of a little grain, and this only on local markets. The retail shops would buy their grain from OPAM. They would have no interest in selling below the official price. But they would have an interest in buying below OPAM's wholesale price (prix de retrocession). The possibility would be limited by putting a brand name on the commodities.
>
> This brand name matter raises delicate problems. It seems that the short-term solution would be "micro-packaging" (micro-conditionement), for example, packaging in 5 or 10-kg bags. But the costs of this operation, which would have to be done all over the country in order to avoid raising transport costs by making grain shipments obligatory, is high at the same time that results are uncertain because of the difficulties of control.
>
> We are forced to recognize that there's a problem here: it will only be overcome when innovative actions will make OPAM's services superior to those of traditional trade... [1]

Other basic recommendations in the CEGOS Report have major inadequacies or inconsistencies, though perhaps none so fundamental as the one just described:

(a) The report recommends a rise in producer prices for foodgrains, but the rationale for this increase is nowhere explained or defended. In fact, the main thrust of argument is that a price rise is unnecessary (because marketed output is not price-responsive) and undesirable (since marketed output may come mainly from larger farm holdings).

(b) The report proposes the purchase at a fixed producer price of a given quota of grain, with the rest being bought at prices determined by harvest size. The incentive and equity effects of such a system are unclear, and are not much discussed in the report.

(c) The report proposes to subsidize farm-level storage, while making access to FGR grain stores cheaper and easier.

The CEGOS proposals were taken up by the Mali government, which created a commission to make recommendations on implementation. The report of this commission[1] supports the basic CEGOS proposal to strengthen the OPAM grain-marketing monopoly. It introduces a complex system of arrangements, however. In years of good harvests, private traders could act in legality at the wholesale level. When harvests are moderate or short, they would be prohibited from doing so. Thus the commission report estimates that in three years out of five, private traders would be restricted to retail sales; no private shipment of cereals of more than one ton would be allowed beyond the arrondissement level.

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[1] Author's translation.

The enforcement of this prohibition of grain shipment presents mind-boggling administrative difficulties in West African conditions. The IPGP commission proposal requires control of all grain movements exceeding one ton -- i.e., ten sacks. But thousands of vehicles carry such quantities of grain in Mali. Every cart, every private vehicle, every bus, would be a potential violator of grain shipment prohibitions. Unless OPAM were to use only its own trucks, every private transporter would have to be given the appropriate papers, with specification of cargo and destination. Multiple check points would presumably be required. Some surveillance and control might be required at the local periodic markets, of which there are hundreds. Opportunities for administrative abuse and corruption would be abundant.

The economic disadvantages of systems of shipment control are well known. To the extent that these controls are effective, they raise prices in deficit regions and reduce them in surplus regions. They discourage production and marketing in the more productive zones and encourage local self-sufficiency rather than regional specialization. They raise prices generally by substantially increasing transaction costs for illicit grain movements, to the extent that these continue.

3. Liberalization

These recommendations to enforce the state's legal monopoly have not been adopted by the Mali government, and since 1976 a third set of proposals has come forward, which recommends movement in the opposite direction - i.e., toward a greater role for private trade and a dilution of OPAM's monopoly status.

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[1] République du Mali, Institut de Productivité et de Gestion Previsionnelle, Rapport Final de la Commission Interministerielle Sur la Restructuration de l'OPAM, Août, 1976.

One of these proposals was not specific to Mali, but arose in the context of the Club du Sahel. The Grain Marketing, Price Policy and Storage Working Group of the Club commissioned a "diagnostic study" in 1976, which was done by the Center for Research on Economic Development of the University of Michigan. An early draft of the report of that study argued that basic improvement in the grain marketing situation in Mali (as in Niger and Upper Volta) required that the private trade be legally recognized and private traders encouraged. This recommendation was hotly debated at a meeting of the Club Working Group in early 1977, and was resoundingly rejected by that group, which consisted of representatives of the Sahel governments (many of them officials of state grain marketing monopolies) and several donor agency spokesmen. The final report made no recommendations; it rather defined a set of options; including liberalization, and assessed advantages and costs.

The most recent proposals come from a multilateral mission composed of representatives of five bilateral donors under the sponsorship of FAO.[1]

This mission report first stresses the gravity of the present situation in grain marketing and the urgency of the need for change. The "restructuring" of the cereals sector, it states, has become "imperative". Three reasons are given: the "excessive" annual budget deficits to which OPAM's "exorbitant indebtedness" makes a major contribution the present system's failure to encourage production, "which stagnates despite a vast potential", and its parallel failure to supply consumers with moderately priced foodgrains; the big differential in grain prices between Mali and her neighbors, which encourages smuggling so that even in a normal year

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[1] FAO, La Politique Cerealiere au Mali, Rapport preparé sur la base des travaux de la Mission Internationale place sous la coordination de H. de Meel, Rome, 1978.

(1977-78), the country had to call on food aid and commercial imports amounting to some 60,000 tons.[1]

The report rejects at the outset the possibility of an effective state monopoly, i.e., suppression of private trade. Traders are said to perform "indispensible functions;" "they will always exist because they have a useful and important function which cannot be otherwise performed".[2] The monopoly option is "unrealistic".

Three "practical" options are set out. The first is to give OPAM greater resources, allowing it to raise producer prices and also raise its marketing margins, so as to reduce its deficits. Retail prices would rise appreciably.

While this option is said to have numerous advantages (reduced OPAM deficits, reduced smuggling) it is rejected because it would require increased public expenditure, compensating wage increases and hence increased budget strains. It would also leave intact the double market system, which OPAM would be unable to dominate.

The second option is to turn the entire domestic grain market over to the private traders (who already have three-quarters of it anyway). OPAM would retain a monopoly of imports and exports and would manage the food security stocks.

The report lists many advantages for this option; it displays, in fact,a restrained lyricism about the results;

> The advantages of this option are first its simplicity and its economy. It costs the state little, since security stocks would continue to be externally-financed. OPAM's debts and structural losses would vanish. The right prices (_la verité des prix_) would prevail, and the role of private traders would be recognized. The double market would disappear. Smuggling would be discouraged in years of bad harvest, once local prices would rise. The supplying of towns and deficit zones in case of scarcity is assured by the state through its security stocks.[3]

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[1] FAO, op. cit., pp. 8-9.

[2] Ibid., p. 6.

[3] Ibid., p. 10.

But, says the report, the principal social objectives are not attained by this option: "...there is no guarantee that the cities will be properly supplied other than in periods of emergency, nor that retail prices will be affordable. Nor is there any guarantee that producers will receive remunerative prices in periods of abundance..."

For these reasons the mission proposes the adoption of a third option. Private trade will be legalized; traders will be licensed , and will compete in primary marketing with the opérations, and, to the extent possible, with the cooperatives. OPAM will control the market by buffer stock operations around a ceiling (retail) and a floor (producer) price. The floor and ceiling prices would be freed "in principle" for several years, but the report is vague on this point; it also calls for annual reconsideration of the prices. The report also proposes that the floor and ceiling prices be regionalized - set higher in deficit regions, lower in surplus areas.

There's little doubt that this multilateral donor/FAO report addresses fundamental issues and puts forward more operational and more promising proposals than the earlier reports. The private sector is legalized and given a central role. The proposals for market control stress indirect measures -- use of the market mechanism via purchases and sales from buffer stocks, rather than direct administrative measures. The report deals with broad strategy, not detail, and proposes a more deliberate, in-depth set of studies to guide implementation. The report comes with a stamp of approval, in some sense, of the five most concerned bilateral donors, so its impact and audience may be larger than is normally the case with such documents.

The proposals nonetheless present certain difficulties which threaten their viability. The sticking-point is price policy, in particular the scheme for inter-annual price stabilization.

Certain elements in the physical and economic environment in Mali put constraints on any price policy which stimulates supply above "normal" or "market-determined" levels. This is the case with policies which attempt to set higher-than-market prices for foodgrains, as it is for policies which aim at stimulating production by providing stable prices to producers. First, grain production is highly variable from year to year because of wide annual variations in rainfall and the close dependence of harvest size on the volume and distribution of rainfall.[1] Secondly, marketed grain output -- the "disposable surplus" -- varies by even more than total output. A good harvest increases the surplus available for sale by a multiple of the increase in total production[2] Thirdly, the price elasticity of demand for foodgrains is probably relatively low -- i.e., consumption does not increase by much as price falls, nor fall by much as prices rise. This means that changes in marketed output tend to lead to sharp inverse changes in grain prices. Finally, in normal years, domestic production almost entirely staisfies domestic demand, i.e., net foodgrain imports are marginal. Opportunities for import substitution are small, since wheat is the only significant grain import, and is imported in relatively small quantities.

Assuming that grain production, and especially marketed supply, is responsive to price, a positive price policy -- one which sets producer prices at higher than market-determined levels, or maintains a stability of prices which stimulates output -- will generate "excess supply". The question of its disposal will have to be faced.

There are four main possibilities: the grain can be sold to consumers at a subsidized price: it can be stored for stabilization or emergency reserve purposes; it can be used in new ways -- as feed for cattle or poultry, for example, or it can be exported.

The first possible use of a price-induced "excess" cereals supply, sales on the domestic market, founders on the troublesome barrier of sluggish demand. Given the low price elasticity of demand for millet and sorghum -- the basic grains -- the consumer price would have to fall very low in order for consumers to absorb significant quantities of additional output. However, this implies subsidization if the "positive" producer price policy is to be maintained, and subsidization raises questions about equity, incentive effects and macroeconomic consequences for which there are no obvious answers in the present state of knowledge. The question of who benefits and who pays, for example, depends on the socioeconomic position of those who buy grain and those who sell. If it is true, as is sometimes claimed that the bulk of marketed millet output comes from a relatively small number of larger farmers, while pastoralists and deficit peasants in poor regions buy much of the marketed millet, then what is involved is a transfer of income from relatively poor to relatively better-off groups.[1]

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[1] Cf. IBRD, West African Foodgrain Study, Sept. 1976, p. 25.

[2] If production is one million tons, of which 150,000 are marketed, a rise in production to 1.1 million tons will increase the saleable surplus by as much as 67%. Of course, some of the increase in production will be consumed by the producers, either because they formerly produced too little to meet their own needs or because they want to consume more grain as part of the general increase in income implied by the larger harvest. But it is probable that most of the increase will be sold.

On the incentive side, the higher food grain price may lead not to an expansion of aggregate agricultural production but to a change in the crop mix, with millet and sorghum being substituted for cotton and/or groundnuts. The macroeconomic effects of this change may not be positive -- e.g., national income will probably be lower and the balance of payments less favorable as a result. There are also budgetary implications, with revenues declining and expenditures rising as a result of the grain price and subsidy policy.

If the "excess" grain that is purchased one year can be stored and then sold the following year when the harvest is poor, the problem will be reduced but not eliminated. If producer prices are set above the long-run average market-determined price, there remains the problem of what to do with the induced increase in grain supply in the face of highly inelastic demand. If price stability as such provides incentives to higher production, there will be more output than otherwise. Moreover, it is not possible to postulate a nicely oscillating cycle of good years and bad. It is highly likely that there will be a number of successive good years before a bad one. In the absence of export markets, the accumulation of grain stocks is the most likely consequence. The costs of this storage, including costs of losses through infestation, spoilage and quality deterioration, are likely to be considerable.

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[1] There exists no study of this question in Mali, nor indeed are there many studies of it elsewhere. The CEGOS Report suggests that better-off farmers are responsible for much of marketed output.

Surplus foodgrains could conceivably find other uses, particularly given the relatively low prices at which they might be offered for non-food consumption. The most obvious and frequently mentioned possibility is in the area of feedgrain for poultry and cattle. This is certainly an interesting and important possibility, but is not clear that the potential feedgrain market is at present capable of absorbing more than a relatively small volume of grain.

There remains the export possibility, which is real. The recent West African Rice Study done by the Stanford Food Research Institute in conjunction with WARDA, indicates that Mali can export rice to the Ivory Coast at competitive and socially profitable prices, assuming world rice prices behave as now projected. The Sengalese rice market, dominated by much cheaper Asian broken rice, is more difficult to penetrate. On the other hand, Mali may be able to export millet/sorghum to Senegal and other neighboring countries.[1]

While export potentials certainly exist, there remain many uncertainties, and in all cases many obstacles to be overcome - in transport and in marketing in particular. The export possibilities for millet and sorghum seem less promising than for rice mainly because exporting surplus would be available in good years, when external demand is low. It would be imprudent to base a general foodgrains price policy on export potentials without knowing more about the nature and dimensions of these potentials.

We have thus far concentrated on price levels, not stabilization, which the FAO Report stresses. Many of the considerations above apply to the proposal to stabilize grain prices interannually. There are other reasons why interannual price stabilization is difficult, risky and expensive.

First, as noted earlier, marketed supply is a small proportion of total production and is subject to especially large changes as total production changes. Thus, interannual stabilization efforts will require considerable storage capacity relative to the total size and value of marketed output. An interannual stabilization effort is, in this sense, likely to be expensive.

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[1] According to one estimate, Malian sorghum can be delivered in the interior of Senegal more cheaply than U.S. sorghum (1976 prices). The reason is that transport costs to Kaolack from Dakar, within Senegal, are substantial (S. Michaelof, Remarques Génerales sur la Commercialisation et la Politique du Prix des Cereales au Mali, Caisse Centrale de Cooperation Economique, Services d'Etudes Economiques et Financiéres, Mars, 1977, p. 26).

Second, interannual grain stabilization has certain inherent contradictions. The presumed primary purpose of attempting to stabilize prices is to reduce the producer's uncertainty; fluctuations in price are believed to deter efforts to expand production. However, a price stabilization scheme which effectively reduces uncertainties could be sustained only at great cost, for it implies a support price that would be maintained over a period of years, regardless of harvest size. Such an inflexible support price would mean large storage costs, should there be a succession of good harvests. Moreover, if the reduction of farmer uncertainty leads to increased grain production and marketings, this too would have to be bought up by the stabilization agency in order to maintain the support price.

On the other hand, if the grain agency reduces its support price as annual harvests and market conditions change, it undermines its primary objective: reduction of producer uncertainty by reduction of price fluctuation.

Third, price stabilization schemes can be destabilizing if the stocks held by the stabilization agency are not large. If the harvest is bad, traders may recognize that sales from the buffer stock will be inadequate to maintain the official price ceiling. They will have nothing to lose by hoarding grain, while they await the inevitable rise in price when the buffer stock is exhausted.

Finally, the presumed incentive effects of stable prices remain unproved. One can argue that what Malian farmers need and want is an assured market, better marketing services, reduced exposure to arbitrary action and the right to sell grain at market prices. These kinds of changes would have a greater effect in stimulating production and marketed supply than would any price stabilization scheme.

Given the high costs, high risks of failure and limited benefits attached to interannual grain price stabilization schemes, it is unclear why such a scheme is proposed in the FAO Report. If the authors believed in the importance and efficacy of such arrangements, they do not demonstrate it in the report. If its inclusion is tactical -- giving OPAM something so as to improve the general acceptability of the report, than it would seem to be an error. An intra-annual price stabilization scheme would have been tactically preferable. Such schemes, while not without problems, are easier to implement, less risky, and less costly. They might also have some genuine social benefits. If distress sales are common (peasants forced by indebtedness to sell at low prices immediatley after the harvest), an effective intra-annual price stabilization is more finely targeted in terms of reducing possible exploitation of peasants by traders due to imperfect markets and unequal bargaining power.

Despite its dubious recommendation of interannual price stabilization, the FAO Report provides a workable basis for meaningful reform, unlike many other reform proposals which have been made in Mali in the past few years. If the proposed ceiling (retail) price can be kept high enough, and the floor (producer) price low enough, the proposed fourchette idea may prove an ingenious device for giving freer play to market prices. What remains highly problematic is whether in time of short harvests the Mali government will allow official consumer prices to rise to the market-determined level, and whether it will allow OPAM to pay producers the market-indicated prices.

In this most recent set of reform proposals, as in many similar documents, one senses a divergence between what the report writers think is the best reform option and what they think it is feasible or politically acceptable to say. Few readers could fail to be convinced that the FAO Report's second option -- very limited government intervention in marketing and pricing -- is the favorite. Its advantages are listed at some length, and with enthusiasm. The countervailing reasons given for its rejection are perfunctory and not at all persuasive. Some of this may derive from the report's joint authorship. But it is more likely that the rejection of the essentially free market option represents a concession to "realism", a strategic choice deriving from some combination of diplomatic necessity and political assessment.

It may be that the rejection was "correct" in that the free market recomendation was inappropriate as well as imprudent. After all, the free market solution is not easy to introduce, nor is it without risks and flaws. The one recent effort at real liberalization (in 1969) showed that it could only work as part of a basic transformation -- the generalized revision of all agricultural prices in line with market forces (including prices in neighboring countries) and the freeing of border trade. Timing is also critical; introduction of greater liberalization requires a favorable general economic environment -- good harvests in particular.

But the exigencies of an effective reform in the direction of liberalization is not the main point. It is rather that the hesitancy of reformers to take exposed positions on ideologically sensitive issues may be a serious long-term obstacle to marketing reform. For it has thus far prevented open discussion of the full gamut of policy alternatives and prohibits a serious consideration by Malian decision-makers of the full set of possible solutions to their country's marketing policy dilemmas.

F. External Support

Foreign assistance reduces the economic costs of maintaining the existing marketing arrangements, and in this sense impedes reform. Food aid (though of course necessary in time of crisis) reduces the impact of inadequate policy. More specifically, inflows of aid in the form of grain which is sold by OPAM, facilitates the generation of working capital for OPAM and thereby reduces the stresses of financial deficits caused by price policies and marketing/storage inefficiencies. Also, the existence of the line of credit available to Mali in the Opérations Account in Paris has generally diluted the negative impacts of grain marketing policy, as it has done with other economic policies, allowing the Mali government to maintain ineffective policies without having to fully suffer the consequences.

III. Conclusions

I have tried in this paper to outline the main problems of grain marketing policy in Mali and to indicate the obstacles to improvements in that policy. Mali is the focus of discussion because it is well documented, and because it is analytically simpler to discuss one country rather than the region as a whole. Much of what has been said is applicable elsewhere in semi-arid West Africa.

Of the many general conclusions that emerge from this analysis, six seem worth special emphasis.

1. It is clear that the West African environment imposes numerous and severe constraints on public policy options in grain marketing. Total grain output is highly dependent on rainfall; hence it is variable. Marketed output is only a small share of the total and is potentially volatile in volume. The country is large in physical size; grain production is spread over vast areas; there are few specialized grain traders; traditional marketing is small in scale and dispersed in space. Frontiers are numerous and highly porous; traditional trade has always ignored them. The financial environment is similarly constraining. Budgets are in deficit. Expenditures are mainly on salaries, which are, moreover, under continual erosion in real terms. Little public money is available for materials, supplies, maintenance. The budget process is at once rigid and uncertain. Intrapublic sector accounts are in frequent disarray. On top of this there is limited availability of trained people, scarcities of organizational inputs and particular scarcities of coordination capacities. These physical, financial and organizational factors put down clear limits on what the Mali government can effectively implement, either in terms of price policies or direct state trading operations.

2. The present mixed system of marketing cannot be easily patched up. Stable coexistence between OPAM operating along its present lines and the private marketing sector requires effective price stabilization or abandonment of significant price support objectives, introduction of a much more refined price structure, abandonment of uniform nationwide pricing, harmonization of prices with neighboring countries. And after all this was done, most of the flaws and inequities of the present system would still be present.

3. Grain-marketing policies have probably had significant negative impact on grain production and the attainment of the priority objective

of food self-sufficiency. Uncertainty over prices and the availability of marketing services, and general market disorganization, have probably led to diversion of farmer effort to cash crops where this has been possible and may have led to a reduced farmer willingness to undertake greater efforts, or new ventures, in the grain production area. These effects have not been of larger magnitude, or at least more apparent, because of the partial nature of OPAM's monopoly -- i.e., the fact that the government has not been able to fully implement its policies. The substantial availability of food aid during the last decade has also been significant in diluting the effects of policy, as has the availability of credit from the French Opérations Account, which has indirectly financed OPAM's deficits by underwriting Mali's ongoing budget and balance of payments deficits.

4. The longer-term impact of the present marketing policies may be of greater significance than the impact on output in the short run. As things now stand, the development of true cooperatives is extremely difficlult. The existing cooperative organizations are instruments of government, used mainly for grain requisition purposes. So long as the requisition system endures, farmers will hesitate to set up organizations for defense of their interests (in the areas of storage, credit, and crop sales for example). So the democratic development of the countryside is impeded. Similarly, the development of trading competence, techniques and capital is severly obstructed, since traders presently operate with strong discouragement or at best, uncertainty. Finally, to the extent that marketing functions are transferred to the opérations de développement, the production-oriented activities of those organizations will be compromised. These opérations are highly dependent on foreign financing which cannot continue forever. They thus have a moment in history, so to speak, to help Malian farmers increase their productivity. Diversion from this effort, or weakening its effectiveness, could therefore have substantial effects on long-term development.

5. Of the many factors which have been responsible for the slow reform of the marketing system, two seem particularly critical. The first is the

lack of firm knowledge about how the grain markets actually function in Mali, due to a lack of basic studies. The sparsity of knowledge allows continued circulation of beliefs which may have little foundation in fact - such as belief in monopsonistic markets. In any case, it is difficult to frame suitable policies in the absence of better information and understanding about farmer decision-making, the pattern of grain selling and buying, the structure and functioning of grain markets, on farm storage economics, and the behavior of grain prices.

The second factor has been poor reform-mongering. Until very recently, the Mali government had not been presented with proposals which were well thought through and operational. Some have been highly management-oriented, indicating how OPAM could organize its work better. But these never addressed the basic problem of what OPAM's work could or should be. The most extensive reform proposals, those of the IDET/CEGOS Report, contained loose ends of a fundamental kind. They never showed how the full state monopoly which was proposed could be implemented. The Mali government commission which took the CEGOS recommendations the next step put forward an extraordinarily complex proposal involving exclusion of traders from wholesale trade during "bad" crop years, and a Draconian system of shipment control, to prevent movement of grain from surplus (low price) to deficit (high price) areas. Present proposals for reform are more viable, though there remain questions about the feasibility or desirability of key recommendations.

6. Certain policy implications should be clear from this discussion, though they have not been made explicit since it is not the purpose of this paper to propose policies but rather to make clear the nature of the problems and the obstacles to change. First of all, it is evident that no marketing reform can hope to succeed without allowing a fuller role to the private trading sector. It is equally evident that as noted in #1 above, scarcities of manpower and other critical inputs severly constrain what the state sector can effectively do; but it should at the same time be stressed that a state grain agency has a major role in grain marketing. It would manage a grain security stock; manage grain imports, particularly crisis imports; provide market information; and perform market inspecting functions. It

might buy and sell in the open market for special purposes -- e.g., localized production crises. It might operate a buffer stock for seasonal price stabilization. It could do grain storage extension work, especially for new grains such as maize. It could provide for the needs of collective consuming units, such as the army,

It is also equally obvious that major improvements in grain marketing can and will come from indirect measures: improvement and extension of feeder road networks; better information on crop size, prices, marketing, etc., and more effective spread of this information; closer attention to relaxing production constraints in foodgrains; improved policy analysis capacity within government; more basic studies about how grain markets work, about farmer behavior with respect to production decisions and crop disposal, about grain storage, about price bahavior in markets at different echelons of the distribution chain. More and better knowledge and changes which indirectly improve market structure and performance will widen the options for reform and increase the probability of adoption.

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DAKAR, SENEGAL

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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Clark G. Ross
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USAID/csd-2547
Center for Research on Economic Development
The University of Michigan
Ann Arbor, Michigan

USAID/AFR/C-1257
Dept. of Agricultural Economics
Purdue University
W. Lafayette, Indiana

Center de Recherche Economique
Appliqué
Université de Dakar
Dakar, Sénégal

GRAIN DEMAND AND CONSUMER PREFERENCES - DAKAR, SENEGAL

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Preface

This study of grain demands in Dakar, Senegal was a joint effort by the Center for Research on Economic Development (CRED), University of Michigan (Grant: US-AID/csd-2547), Purdue University (Grant: US-AID/AFR-C-1257), and Centre de Recherche Economique Appliquée (CREA).

In Dakar, the interviewers were supervised by Mr. Samba Tamsy, who also provided valuable guidance in the initial interpretation of the data.

Completion of the work in the United States was facilitated by the preparation of the data for computer analysis under the supervision of Dr. Margaret Saunders of Purdue University. David Jick from the University of Michigan was responsible for the computer analysis of the data set. Helpful suggestions were received from Professors Elliot Berg and Richard Porter (CRED, University of Michigan) and Wilford Morris (Purdue University).

Clark G. Ross
CRED, University of Michigan

CHAPTER I

PURPOSE, METHOD, AND PLAN OF WORK

Section 1 - Purpose and Importance of This Study

This study of food grain demands by the urban population of Dakar should aid Senegalese and other developing country decision-makers in designing effective food policy. Food policy requires an understanding of the marketing habits, grain consumption and demand patterns of a country's population.

Grain imports to sustain many third world countries have led to unfavorable trade balances, hindering development efforts. Senegal, a country of 5.1 million inhabitants (1976) - 30 percent of whom are urbanized, has an agriculturally based economy. Nevertheless, nearly 30 percent of grain consumption is satisfied by commercial imports. Annual rice imports are currently 200,000 tons, costing an estimated $50 million. Most of these imports are destined for the urban population. Official Senegalese policy is to promote food self-sufficiency by increased domestic rice, millet, and maize production.

Two questions related to grain demands must be addressed. First, will the domestically produced Senegalese rice possess characteristics acceptable to the urban population? Second, will the urban population shift the composition of its grain diet towards increased millet and maize consumption? These are the two central issues on which this study focuses. Some information on the Senegalese agricultural sector follows.

Groundnuts are the primary agricultural product, with their export receipts financing the imports of rice. Millet production, due to unfavorable rainfall patterns, has been variable; a "good" year Senegal is self-sufficient in millet. Most domestic millet (perhaps 80 percent) is consumed by the rural producer whose diet, while supplemented by rice, is based on millet.

The urban Dakar consumer has a more diversified rice-based diet. Local rice accounts for only 25 percent of estimated national rice consumption, with the remainder commercially imported. As much as 50 percent of this imported rice is consumed in the Dakar/Cap Vert area.

In Senegal, attaining grain self-sufficiency primarily requires a replacement of the rice imports. A possibility would be to increase significantly local rice production; however, the domestic resource cost of this rice exceeds its current market price. Thus, economic costs to the domestic economy are associated with this alternative. Also, this local rice has characteristics differing from the imported Siam rice to which the Senegalese consumer shows a strong preference.

Another means of reducing rice imports is to increase production of millet and maize. This depends in large part upon the willingness of the Dakar consumer to accept increased quantities of these cereals. Thus, a range of policy choices exists, extending from a continuation of heavy rice imports to their replacement by domestic rice or by domestic millet and maize.

Section 2 - Method

Seventy-five households were sampled in this study, which employed three interviewers. To assure representation from all major Dakar neighborhoods, a target number of households per neighborhood was set. The interviewers then selected the households within the neighborhoods assigned to them. Such a procedure was warrented to assure that the interviewers did not know members of a household, fearing that frank responses would be comprised by any acquaintance.[1]

Initially, socio-economic information for each household was collected. Concurrently a questionnaire detailing grain purchase was initiated; the composition of meals eaten by the households was also noted. To determine the qualities of rice sought by the consumer, other questionnaires were introduced, and rice samples given to the households.

A continuing problem was the lack of previous research on grain demands in Senegal. While the IUT was an excellent source of general consumption patterns, it was not a study of individual grain demands.[2]

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[1] In fact, one household withdrew from the sample when it later became known that a relative of the household had been married to the interviewer's uncle.

[2] Institute Universitaire de Technologie; Etude: Budget Consommation: Tomes 1,2 Université de Dakar, Sénégal, Juillet 1975.

Thus, in designing this study, the literature did not provide a useful precedent. Hopefully, this research gives a profile of grain purchasing in Dakar and addresses the two important questions -- substitutability of millet for rice and preferences for rice types.

Section 3 - Plan of Work

Chapter II gives a socio-economic profile of the sample; Chapter III describes the grain purchasing and consumption patterns of the sample. Chapter IV more rigorously analyses the consumer's demand for cereals, estimating demand functions. Finally, Chapter V presents the study's conclusions, focusing on their implications for national food self-sufficiency.

CHAPTER II

PROFILE OF HOUSEHOLDS

This chapter gives a socio-economic profile of the sample households. For this study, "household" is defined to include all individuals who regularly consume their meals together, in contrast to the "nuclear" family.

Neighborhood. -- The seventy-five households were chosen from all major Dakar neighborhoods. Medina, with the heaviest concentration of middle to low-income Dakar residents contributed ten households. Eighteen other neighborhoods provided between one and five households.

Age of Head of Household. -- Consistent with the extended family concept, the mean age of the head of the household is 54.59 (Standard Deviation 12.05).

Ethnic Background. -- All important Senegalese ethnic groups were represented; the Wolof, which comprise about 40 percent of the Senegalese population, are the largest group in this sample.

Religion. -- The predominance of the households were Muslim (69) with six Christian households.

Duration of Habitation at Dakar. -- The majority of the sample (63) have been residents of Dakar for more than twenty years, with the heads of thrity households having been born in Dakar.

Origin Within Senegal. -- The largest concentration of households (33) identified their regional origin as Dakar. Others were primarily from the Fleuve and Groundnut Basin.

Average Household Size. -- The average household consisted of 11.37 (S.D. 3.14) individuals.[1,2]

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[1] Accurately measuring household size is complicated by seasonal urban-rural migration, existence of multi-household individuals, and other periodic changes in household membership.

[2] The IUT consumption study for Dakar indicated that the average family size was slightly in excess of seven individuals. The observed differential between the IUT study and this work is attributable to the definition of family/household used. While the IUT study relied on "nuclear" family units, this study employed the concept of household, as defined above. Since this study concerns grain purchases for household units, it was more appropriate to include all individuals regularly eating together within the unit studied.

The typical household was comprised of 6.33 adults (S.D. 3.35) and 5.04 children (S.D. 2.93).

Occupation. -- A relatively large number of household heads (34) were either retired or deceased. In such cases, other working members were providing household income. Those occupations for working household heads included skilled worker (11), government worker (8), commercial worker (7), and laborer (4).

Income. -- In this survey, three approaches were used to estimate income. First, monthly expenses for major consumer items were recorded. Second, the head of the household classified his income within a range of 15,000 CFA/month. Finally, the interviewer estimated the monthly household income. Considering these three estimates, the following distribution of household income was generated:

Monthly Income Head of Household		Number of Participants
0-35,000 CFA		17
35,001-65,000 CFA		33
65,000+ CFA		25
	Total	75

Mean: 59,600 CFA or $248.00 (at 240 CFA/US$) S.D.: 30,655

This income is often supplemented by contributions from other household members.

Summary of Socio-Economic Profile. -- This description of the sample population has served two purposes. First, it has summarized the socio-economic composition of the sample households. Second, characteristics to be tested for their influence on grain consumption have been identified.

CHAPTER III

CONSUMER GRAIN PURCHASING AND CONSUMPTION

This chapter summarizes the mechanics of the consumer grain purchasing. The consumer's view of the marketing process and his purchasing patterns of millet, rice, and maize, are all examined. Finally, the frequency with which grain-based meals are eaten is examined.

For the purchase of grains, the consumer in Dakar has three options: first, he can purchase grain in one of the many major markets. Second, most small boutiques which saturate Dakar neighborhoods sell grains; finally, the consumer can purchase grain outside of Dakar in rural grain-producing areas.

Of the options listed above, the purchasing of grain in a major market is the most common. A wider selection of grains and types of rice is available. Second, it is more convenient to purchase major food items --- meat, fish, vegetables, grains -- in one market. Finally, there is the rational belief that a major market, attracting many suppliers and consumers, follows more competitive pricing practices.

Section 1 - Markets Used and Frequency of Use

All seventy-five households had a regular market generally chosen for its proximity to the consumer's home. The markets at Castor (24 households), Gueule Tapée (13), N'Guéla (9), and M'Babass (7) were the most frequented. The Dakar consumer made 6.6 (S.D. 2.46) visits per week to the market with the majority (60) attending the market daily.

Section 2 - Millet and Sorghum Purchasing

Most households (69) regularly purchase millet, with only two regularly purchasing sorghum. Most consumers claim that millet has a superior taste and is more nutritious than sorghum. The data collected indicate that 65 of the households purchase millet at least once a month; 42 buy millet at two-week or shorter intervals.

The following table indicates that the vast majority of consumers always purchase millet in whole grain form.

FORM OF MILLET PURCHASED

	Whole Grain	Flour	Cous-Cous
Never	19	66	63
Occasionally	3	3	5
Usually	0	1	0
Always	53	5	7

All but one of the heavy consumers of millet (those eating millet four or more times per week) always purchase millet in grain form. It is generally the occasional consumer of millet who buys cous-cous or flour. This suggests that the greater economy in purchasing grain millet outweighs the added time of preparation associated with the grain form; such a conclusion implies that programs to promote prepared millet flour or cous-cous could face consumer resistance if too large a price differential between the grain form and non-grain forms results.

Consumers generally responded that they purchased millet in grain form because it was more economical. They paid for the decortication at neighborhood machines, then transforming the flour into cous-cous themselves. The few families purchasing flour or cous-cous cited the greater ease of preparation with these forms.

Households responded that their purchases varied little during the calendar year. Increased purchases during the Muslim fast month of Ramadan were cited, to prepare a nutritious and filling millet porridge. Most households purchase small quantities of millet (less than 20 kg) at a time. Only twenty-two households purchase millet in bulk form. The typical household only consumes millet about 2.5 times per week (S.D. 4.29).

Some relationship between millet consumption and origin within Senegal was observed. Families from the Fleuve and Casamance regions, two rice-growing areas, consumed slightly fewer millet-based meals per week than the sample group (2.14 vs 2.47).

The preponderance of households (70) claimed that millet was exclusively consumed in the evening. These results suggest the great difficulty in replacing imported rice by locally grown millet. Since rice is consumed primarily at mid-day, it is questionable to what degree millet and rice are substitutable products.

Most consumers (55) did not have a regular millet seller. These households purchase millet after comparing the price and quality of the various sellers. Those claiming a regular millet seller cited personal rapport (i.e. credit availability) as their motivation for selecting the seller.

Income (5 respondents), difficulty of preparation (13) and digestibility (4) were the most commonly cited reasons for not consuming more millet; to some extent these factors can be affected by governmental policy. Most households (22) cited a preference for rice or for a diversified diet (21) as their reason for not consuming more millet. Inducing these households to consume more millet through national policy is difficult. This issue is important, since policy makers have suggested various actions aimed at increasing millet consumption, including institutionally prepared cous-cous or flour, and certain marketing reforms. A full two-thirds of the sample, however, indicated that their consumption of millet was sufficient. The tentative conclusion is that millet consumption is not primarily restrained by factors subject to policy manipulation.

In summary, the typical consumer purchases millet in grain form, in small quantities about twice per month. The ten millet meals per month typically were eaten exclusively in the evening.

Section 3 - Rice Purchasing

Rice forms the staple food grain in the typical Dakar diet, with all seventy-five households regularly purchasing rice. Most households (69) purchase rice once a month, with 11 households purchasing rice daily. The mean size of purchase per market visit was 95.47 kg (S.D. 63.50). Those purchasing rice daily are primarily poorer households, receiving a daily income from small commerce or trying to avoid waste or overconsumption.

All households indicated that their daily consumption of rice during the year was stable. Most households (61) said they usually ate rice at mid-day. This observation is a direct corollary to that found concerning millet consumption; all households eating millet (70) ate millet exclusively in the evening.

Slightly more than half the households (39) had a regular rice seller, with twenty-two citing personal rapport/credit as the reason. Only seven of the households purchased rice and millet from the same trader; generally, it was claimed that the trader did not sell both grains.

As with millet, households felt their present consumption of rice was adequate. Seventy-one claimed they had reached a saturation level with rice; only four households claimed that income constrained their rice purchases. Three of those four households had a monthly income of less than 20,000 CFA. Thus, even households with relatively low incomes (20,001-50,000 CFA/month) did not cite income as a constraining influence on rice consumption.

In Dakar, imported rice from different geographic origins is available. Local Senegalese rice is primarily producer-consumed and rarely found in Dakar market. Siam rice was preferred by the vast majority (48) of the households. Subsequently, thirty-three households admitted that they were unfamiliar with Senegalese rice.

The popularity of Siam rice was confirmed by a questionnaire asking the consumer to rank his order of purchase among four kinds of rice at varying prices.[1] The types of rice used in this experiment were Siam, Pakistan-improved, Gambian, and Pakistan-ordinary.[2] At equal prices (80 CFA/kg) the Siam was preferred by forty-seven households, followed by the Pakistan-ordinary (2). In the next round of questioning, the per-kilogram prices were changed to Siam: 90 CFA, Pakistan-improved: 85, Gambian: 80, and Pakistan-ordinary: 80. The Siam continued to be the preferred purchase for twenty-nine households. Following an additional price rise for the Siam from 90 to 95 CFA/kg (all other prices constant) an additional ten households chose a lower-priced rice. Of interest is the fact that nineteen households, or 40 percent of the sample, were willing to pay a substantial premium for the Siam rice.

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[1] The consumer was asked to estimate the habitual quantity of rice he purchased. Obviously, some consumers would be induced to purchase a smaller quantity of a preferred rice as that variety's price rose. In this case, the intensity of a consumer's preference for the Siam rice would actually be understated.

[2] The Pakistan imporved was a very clean and low-oil-consuming Pakistan variety which had been previously given to the families in a rice-testing experiment. Only fifty families participated in this questionnaire.

This behavior appears influenced by the income of the household. The twenty-nine households choosing Siam at a 5 CFA premium had a mean monthly income of 65,000 CFA, in contrast to the 59,600 mean sample income. The mean monthly income for the nineteen households which continued to choose Siam at a 10 CFA premium was 72,632 CFA. The sensitivity of rice purchasing to income is revealed by this experiment. Not only is the quantity of rice demanded sensitive to income, but the price elasticity of each type of rice seems to vary with income level.

These results are important in two respects. First, the consumer's strong preference for the Siam rice variety and his willingness to pay a premium for that rice have been shown. Second, the local Gambiam rice, similar to rice varieties found in the Casamance, was not well appreciated. In this experiment, when price-induced switching of purchases did occur, it was generally form the Siam rice to the Pakistan-improved. Thus, rice varieties are not perfect substitutes, and replacing Siam rice by a locally grown rice would meet consumer resistance.

Exploring consumers' preferences towards rice, two attempts at determining the qualities of rice sought by the consumer were made. Those qualities considered were volume of rice after cooking, absorbtion of cooking oil, taste, time of preparation (cleaning and cooking), and the quantity of water absorbed. From direct questioning, volume and oil absorption, both directly related to the final cost of the meal, emerged as the most important characteristics.

These results were confirmed by a more rigorous goal hierarchy test which provided the following common scale ranking values.[1]

Volume	1.00
Oil Absorption	.926
Taste	.453
Preparation Time	.270
Water Absorption	0

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[1] Harman, Wyatte, "An Evaluation of Factors Affecting the Hierarchy of Multiple Goals," Oklahoma State University, Technical Bulletin T-134, June, 1972.

These two tests provided the same ranking of rice characteristics. The general consensus is that Siam rice best approaches the volume/oil requirement. Also, the Siam rice has a taste appreciated by consumers. Thus, the group's strong preference for the Siam rice is understandable.

In summary, rice is generally purchased once a month in 100-kilogram quantities, with the consumer having a habitual rice seller. All households ate rice at mid-day, many also eating rice in the evening. Volume of rice after cooking and oil absorbtion were those qualities most important to the consumer, with Siam rice best satisfying these requirements. Due to the close scrutiny given rice varities by the consumer, replacing the imported Siam rice by a local variety could meet strong consumer resistance.

Section 4: Maize Purchasing

Dakar households consume very little maize, either in grain or flour form. Forty-one households never purchase maize, and only seven claimed a weekly consumption in excess of four kilograms. Of the thirty-four households purchasing maize, thirteen purchased in grain form and twenty-one purchased maize flour. Those purchasing maize grain often grind the maize to mix with millet in cous-cous, while those purchasing flour often prepare a maize porridge.

Most households (44) said their consumption of maize was limited by their preference for rice; twenty respondents cited the difficulty in preparing maize. Households generally expressed a dislike for or an ignorance of maize-based meals. Locally grown maize has great potential, with high-yielding maize varieties having been successfully introduced in Senegal. If urban maize demand could be stimulated, a rapid supply response is possible with consequent declines in rice imports. Public policy should be aimed at educating the urban population to the various types of maize-based meals.

Section 5: Grain Consumption Patterns

The interviewers visited the households daily, recording the composition of each meal for three weeks. As the following table shows, the typical household has a rice-based meal nearly every day at noon with little variance (coefficient of variation is .098). Mid-day millet consumption was insignificant, consumed only three times by two households during the three week period.

NUMBER OF GRAIN BASED MEALS PER WEEK[a,c]

	Millet	Rice	Total
Noon	.02	6.71	6.73
	(.11)[b]	(.66)	
Evening	2.06	1.97	4.03
	(1.45)	(2.14)	
Total	2.08	8.68	10.76

[a] Based on a three-week average.

[b] Standard deviations are in parentheses.

[c] Due to the more intensive nature of this questionning, only forty-four of the original seventy-five households were maintained in this phase of the research.

The typical household consumed two millet-based meals per week in the evening. Rice competed with millet in the evening with a mean of 1.97 rice-based evening meals. On average the household consumed grains at 10.76 meals per week, of which 8.68 or 80 percent involved rice.

Within this rice-based diet, 6.71 of the 8.68 (77 percent) weekly rice meals are consumed at noon, suggesting that at least 77 percent of all rice consumed in Dakar is prepared at mid-day. These noon meals of fish and rice are more rice-concentrated than evening rice meals. Thus, food self-sufficiency requires replacing imported rice at noon. As the frequency of millet in noon meals indicates, millet may not be a viable alternative to rice at mid-day.[1]

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[1] These results are supported by a survey of meals eaten by the rural population of the Sine-Saloum in Senegal. Nearly 85 percent of all rice meals were eaten at noon. Millet meals predominated in the evening, with 96 percent of all cous-cous consumed in the evening. Thus, even in a millet dominant region, the relative heaviness of cous-cous restricts its consumption to evening meals. (See: Yaciuk, G. and A.D., "Discussions des Resultats de l'Enquête sur la Technologie Post-Recolte en Milieu Paysan Au Sénégal." November 1977, pp. 51-52.)

In the evening, some limited possibility for substituting millet for rice does exist. For instance, inducing households to substitute one evening meal for a rice meal per week would reduce the typical household's annual rice consumption by about 135 kilograms.[1] Thus, a 50 percent increase in the frequency of millet-based meals from 2.08 to 3.08 per week would only replace 6,000 tons of imported rice, or about 3 percent of current Senegalese rice imports.

This chapter has shown that the question of grain self-sufficiency for Senegal is complicated. First, the degree of substitutability between rice and millet is not clear. Second, the degree of substitutability between the preferred Siam rice and locally grown rices of differing characteristics is also debatable. The next chapter attempts to derive empirical estimates of the consumers' grain demand functions.

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[1] Annual rice consumption is 1,174.5 kg (see Chapter IV) per household. Reducing total rice meals from 8.68 to 7.68 per week would imply a maximum annual savings of 135 kg of rice per household. This amounts to 6,000 tons for Dakar's population of 500,000.

CHAPTER IV

ANALYSIS OF CONSUMER GRAIN DEMAND

This chapter endeavors to estimate urban grain demand functions using the survey data. The first section of this chapter analyzes total grain consumption, and the second, third, and fourth sections concern individual grains -- millet, rice, and maize, respectively. The empirical results presented here are indicative and should be treated as complementary information to the descriptive material presented in Chapter III. Small sample size and measurement error reduce the confidence which can be placed in the coefficients. Nevertheless, the overall consistency of the results presented in Chapters III and IV help justify the major conclusions.

Section 1: Total Grain Consumption

Various nutritionists place the desired annual per capita milled grain consumption in Senegal at 182.5 kg.[1] Since that standard is rather arbitrary, its use here is only as a reference point. For sixty-two of the seventy-five households followed, the following summary statistics were calculated.[2]

ANNUAL PER CAPITA GRAIN CONSUMPTION (KG) AND EXPENDITURE (CFA)

	Millet[a]	Rice	Maize	Total
Consumption	65.0	103.3	6.4	174.8
Standard Deviation	(20.4)	(27.4)	(18.0)	(37.29)
Percentage	37.2	59.1	3.7	100
Expenditure[b]	3,900	8,264	384	12,548

[a] This includes whole grain, millet flour, and cous-cous. Approximately 95 percent of the weight is whole grain.

[b] Prices of 60, 80, and 60 CFA/kg were used for millet, rice, and maize, respectively.

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[1] This standard has been accepted by the Gambia Basin Study Commission for planning purposes.

[2] Thirteen households were excluded because of incomplete or conflicting data elements. The annual estimates were calculated using data collected during three months.

Estimated per capita grain consumption was only slightly below the 182.5 kg consumption standard. The table shows the dominant share of rice in total grain consumption.

The coefficient of variation is higher for millet than for rice. This is consistent with the belief that rice consumption by Dakar households is relatively invariant to socio-economic influences. The rather insignificant level of maize consumption should be noted. Finally, the mean monthly grain expenditure per household of 11,889 CFA ($54) represents 20 percent of mean monthly income (59,600 CFA).

The variability of grain consumption to key socio-economic indicators is now investigated.

Income Per Household. -- The correlation between income and total per capita grain consumption was insignificant. Tests for relationships between the individual grains and income revealed a significant negative correlation between per capita millet consumption and income. No relationships between income and per capita rice or maize consumption were significant.

Size of Household. --Individual grain demands are positively influenced by household size; however, the magnitude of this influence declines with household size (i.e. a quadratic relationship). The correlations between household size and millet, rice and total grain consumption were all negative and significant. These relationships could be explained in a number of ways. First, larger households may have a greater percentage of children, whose grain consumption is less than that of adults. However, for this sample the correlation between household size and the number of children was not significant, reducing the validity of this explanation. Second, there may be some "economies of scale" in preparing grain-based meals. Smaller households may be required to produce greater quantities of fish/rice or cous-cous than desired, with waste, neighborhood sharing, or reheating occurring. In the later two cases, estimated per capita consumption would be biased.

Finally, there is a tendency for households to purchase fixed amounts of cereals, like a 100 kg sac of rice each month, without complete regard for household size or needs. Consequently, in a larger household the per capita ration of rice would be less than that of a smaller household.

While the data do not permit a resolution of this question, it is important to emphasize that the compositiiton of the household may be a significant element in overall grain demands. Structural shifts in household size may then affect grain demands. Since a per capita planning concept would tend to camouflage such changes in demand, effective planning should consider household size.

Ethnicity. -- No relationship between ethnicity and per capita grain consumption was found.

Length of Time at Dakar. -- No significant relationship between grain consumption and length of time at Dakar was found. It appears that newer residents adopt the prevailing urban consumption habits upon arriving in Dakar.

Section 2: Millet Demand

In this section, millet consumption (estimated at 65 kg annually per capita) will be discussed in greater detail. In the previous section, all millet forms were aggregated. For further analysis the millet form should be identified and isolated. Of the millet purchased during the survey period, 95 percent was whole grain; consequently, this section discusses demand for whole grain millet, netting out purchases of flour and cous-cous.

An important question is the extent to which the estimates of income and price elasticity for whole grain millet apply to cous-cous. Since the vast majority of consumers cited the reduced cost involved in self-transforming millet, the differential cost of an institutionally prepared cous-cous over the grain form must be known before projecting the demand for prepared cous-cous. At some per-kilogram price differential (10 CFA/kg for direct milling costs plus a premium for labor/inconvenience) the consumer would be indifferent in deciding whether to purchase whole grain or prepared cous-cous. Were the price differential less than the above differential, millet consumption would be stimulated; a greater price differential would leave purchases unchanged, *ceteris paribus*, as consumers would continue to purchase the grain form. In summary, the results presented for whole grain milled would generally be applicable for a prepared cous-cous which had a price differential similar to the costs now paid by the consumer in self-transforming millet.

Demand Estimates

Both a simple linear demand relationship and a double logarithmic demand function were estimated.[1] In both cases monthly household millet consumption (mean 61.7 kg) was the dependent variable. The independent variables were household income, price of millet, and the number of adults and children in the household. The estimated equations are presented on the following page.

In both specifications the size of the household is significant. The linear specification suggests that an additional 3.4 kg per month are purchased for each additional household member.[2] The demand response is slightly higher for adults than for children.

The price response and implied price elasticities for millet are quite high, but with very large standard errors. One interpretation of this is that a high price elasticity is possible since millet is consumed almost exclusively in the evening. A wide range of substitute products could be used at this meal. Were the price response this high, millet consumption could perhaps be greatly increased with either technological progress in agriculture or with millet price reductions through national policy. This may be true, but it would only decrease rice imports to the extent that rice is consumed in the evening.[3] As rice is generally consumed at noon and millet exclusively consumed in the evening, the degree of substitutability between the two grains is somewhat limited. Since there are other substitutes for millet in the evening, an increase in millet consumption does not necessarily imply

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[1] The fundamental difference between these two specifications is that the double logarithmic function implies a constant elasticity for an independent variable, but a marginal effect varying with the level of other independent variables.

[2] The point elasticity at the mean for household size is .47.

[3] Due to the constancy of the rice price, it is impossible to estimate the rice cross-price elasticity for millet.

MILLET DEMAND

Variables	Const.	PM	I	N	A	C	F	R^2	SE
Linear I	100.1	-1.25	.00002	3.44			12.81	.40	20.12
	(2.05)	(-1.60)	(.29)	(5.93)			(99.9)		
Linear II	99.3	-1.25	.00003		3.68	3.16	9.51	.40	20.27
	(2.02)	(-1.58)	(.35)		(4.39)	(3.46)	(99.9)		
Logarithmic I	7.81	-1.13	-.05	.617			10.53	.36	.318
	(2.40)	(-1.45)	(-.65)	(5.33)			(99.9)		
Logarithmic II	7.67	-.994	-.41		.37	.20	7.27	.35	.326
	(2.27)	(-1.23)	(-.50)		(4.45)	(2.82)	(99.9)		

61 observations for each equation.

(1) where PM = Price of millet (CFA/kg)
I = Income (monthly household in CFA)
N = Number in household
C = Number of children
A = Number of Adults

(2) T Statistics are in parentheses for the independent variables.

(3) For the F statistic the level of significance is shown in parentheses.

an equal decrease in rice consumption.

The income effect does not significantly differ from zero in any equation. The simple correlation between monthly income and household purchases was also insignificant. Since only five of the seventy-five households cited income as a constraint to consuming more millet (Chapter III, Section 2), income had not been perceived as a major influence on millet purchasing. In contrast, per capita millet consumption was negatively correlated with income. The resolution of this paradox is that by being negatively correlated with household size, per capita millet consumption is spuriously correlated (negatively) with income because of the weak but positive correlation between income and household size.

Two policy implications emerge from this discussion. First, while the relatively strong price response for millet suggests the possibility of using price policy to stimulate millet consumption, increased millet consumption would not necessarily decrease rice consumption. Second, this price response suggests that introducing an institutionally prepared cous-cous which implies a higher cost for a millet-based meal would meet consumer resistance.

Section 3: Rice Demand

Annual rice consumption, estimated at 103 kg per capita, accounts for approximately 60 percent of the consumer's grain intake. The per capita variance of this rice consumption, as measured by the coefficient of variation (.27), is relatively small. Before presenting the demand results it should be noted that rice is sold at a controlled price (80 CFA/kg). This complicates testing the relationship between price and demand, since there is no variation in the rice price. Further, rice demand should be disaggregated by the various types of imported rice with cross-price terms for other rice varieties included in separate rice demand functions. Neither the sample size nor the availability of data permitted such a specification. Critical price levels at which variety switching occurs were discussed in Chapter III.

Demand Estimates

The dependent variable was monthly household rice consumption

(Mean 97.88 kg) with income and household size the independent variables. These estimated equations are given on the following page.

The derived income elasticities are quite low; for the linear specification the income elasticity at the mean is only .12. Rice had generally been assumed relatively income inelastic, since only four households cited income as a constraint to rice consumption.

Household size is the major influence in both demand specifications. The marginal impact of an additional adult slightly exceeds that of an additional child in both equations. These household size variables slightly exceed their analogues in the millet demand equations, consistent with the larger per capita rice consumption.

The lack of information regarding the price responsiveness of rice demand and the relationships among price and rice types is regrettable. The indication from Chapter III is that Siam rice is more price inelastic than other rice varieties. In conclusion, the typical household's demand for rice is primarily a function of household size. The combination of taste/habit for rice and the relative inexpensiveness of the fish/rice mid-day meal maintains a household rice demand little influenced by other factors.

Section 4: Maize Demand

Due to the paucity of households purchasing maize, few statements about maize demand can be advanced. While only eight of the sixty-two households purchased maize during the survey period, their mean monthly household consumption was important, 66.5 kg (S.D. 44.51) This represents an annual per capita consumption of 48.62 kg for these households.

Of interest is the fragmentation of households into those consuming important quantities of maize (8) and those never purchasing maize (54). The reason for this sharp division probably revolves around habit and awareness. Of importance is the fact that maize, more than millet, could be substituted for imported rice. From the demand perspective maize could have greater acceptability than millet, since maize can be ground in a fashion similar to broken rice and consumed at noon with fish. From the supply perspective, replacing rice imports by domestic maize production would be more easily accomplished than by either domestic rice or millet. If maize demand is constrained by families' being unaware of

RICE DEMAND

Variables	Const.	I	N	A	C	F	R^2	SE
Linear I	39.51 (3.64)	.0002 (1.79)	4.11 (5.34)			17.44 (99.99)	.37	26.73
Linear II	38.70 (3.52)	.0002 (1.86)		4.61 (4.14)	3.54 (2.92)	11.63 (99.99)	.38	26.87
Logarithmic I	2.74 (4.19)	.07 (1.20)	.55 (6.39)			26.49 (99.99)	.48	.24
Logarithmic II	3.00 (4.99)	.06 (1.04)		.36 (5.97)	.18 (3.41)	18.37 (99.99)	.50	.24

61 observations for each equation.

(1) where I = Income (CFA/Month)
N = Number in Household
A = Number of Adults
C = Number of Children

(2) T Statistics are in parentheses for the independent variables.

(3) For the F statistic the level of significance is shown in parentheses.

of the many possible ways to prepare maize, some initiative to demonstrate interesting maize meals is needed. If, however, maize consumption is restrained by an absolute preference for rice, the promotion of maize is more complicated.

Section 5: Major Findings

The typical Dakar household is an important consumer of grains, particularly rice. Annual per capita grain consumption was estimated at 174.8 kg. On the household level, grain demands were strongly influenced by the size and composition of the hosuehold, with adults having the larger marginal impact. Income seems to influence rice consumption, but the derived elasticities were very low. Millet consumption appears invariant with income. The influence of own price was strongest on millet, perhaps explained by millet's being exclusively consumed in the evening, when a broad range of substitutes is available. This point is relevant to programs aimed at introducing an institutionally prepared cous-cous. The stimulus from reduced preparation time could be more than offset by a higher price, with millet consumption actually falling.

Another important price issue concerns the consumer's strong preference for the Siam rice variety. The sample group's willingness to pay a premium for the Siam variety shows the difficulty in replacing imported rice by domestic rice. The possibility of greater maize consumption, particularly as a substitute for rice at noon, cannot be completely discounted by the results of this research.

The above findings must be weighed in light of the small sample size and the relatively short time period upon which these results are based. Also, the absence of any price variation for rice can lead to misspecification and biased coefficients. Nevertheless, confidence can be placed in these findings for several reasons. First, the major consumption trends indicated by the data are consistent with observed behavior in Dakar. Second, the data set appears internally consistent. Responses to the introductory questions about general purchasing behavior are consistent with the recorded purchases. Finally, the findings are comparable to those in the IUT study of household budgets.[1] The concluding chapter discusses the implications of these results for food self-sufficiency in Senegal.

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[1] Institut Universitaire de Technologie, Etude: Budget Consommation, Dakar, July 1975. The IUT study indicates a per capita monthly grain expenditure of 1226 CFA compared to 1046 CFA in this study. The IUT study used "consumption units" which effectively reduced household size, since children were weighed less than adults. This partially accounts for the higher per capita IUT estimate.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter examines Senegal's professed goal of food self-sufficiency in light of this study's main conclusions. Essentially, the food self-sufficiency strategy implies increasing domestic production of rice, millet, and maize, as well as shifting the composition of grain consumption towards more millet and maize, with less reliance on rice.[1] Thus, both grain demand and supply components are addressed in this strategy.

Rice production increases could technically be achieved; however, the final market price of that rice, assuming no subsidy element, could exceed 120 CFA/kg. Such a consumer rice price (50 percent higher than the current price) would undoubtedly lead to urban discontent. Significantly increasing domestic maize production is also feasible. Both under-utilized lands in Senegal-Oriental as well as planned irrigation projects from Senegalese rivers hold great potential for maize cultivation.

The results of this study are more relevant to the government consumption targets. First, the targeted 43 percent reduction in rice consumption by 1985 would imply a decrease in annual per capita rice consumption from 103.3 kg to less than 60 kg in Dakar. Based on the demand patterns shown in this study, that goal is unrealistic. The section on grain meals eaten indicated that about 80 percent of all rice is consumed at mid-day. Millet does not appear acceptable as a mid-day substitute due to its incompatibility with fish and its heaviness. Maize has long-term potential, since it can substitute for rice in the traditional fish/rice dish. Thus, a significant reduction in rice consumption is unlikely in the immediate future.

A related point to the rice consumption concerns the planned increase in domestic rice production. Even if the cost-price issue were resolved, there is still the question of consumer willingness to substitute a domestic rice for the currently imported Siam broken rice for which there is strong consumer preference. Limiting imports of Siam rice as domestic rice production increases could simply lead to black market rationing of Siam rice, with adverse efficiency and equity effects.

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[1] Government of Senegal, Food Investment Strategy, Dakar Senegal February 1977, pp. 5-19.

The planned maize consumption increase form 82,000 tons to 170,000 tons by 1985 is ambitious. Undoubtedly, sharply increased maize consumption is possible, but only in the long term, after extensive promotional efforts.

The projected millet flour consumption increase implies a per capita consumption increase of only 12 kg/year. This is reasonable, but two cautions must be addressed. First, the increased milled consumption, undoubtedly in the evening, could be at the expense of other foods beside rice. Second, since millet appears to be quite price elastic, the additional per capita millet consumption cannot be expected if flour processing costs greatly increase the consumer millet price. It may be more prudent for the government to devote its efforts to millet production programs, allowing the consumer to transform the grain to flour himself.

The results of this Dakar consumption study are not entirely supportive of the government's food self-sufficiency strategy. The most critical conclusion is that sharply decreased rice consumption would be difficult to achieve in the short run. In general, this study has addressed the two major issues concerning food self-sufficiency and the urban consumer; the question of substitutability between rice and millet or maize has been examined. Second, the difficulties with replacing Siam rice by a locally grown rice of differing characteristics have been discussed. Continued consideration of these issues is required to design an effective food policy for Senegal.

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A Village Level Study Of Producer Grain Transactions in Rural Senegal

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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Clark G. Ross
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US-AID/csd-2547
Center for Research on Economic Development
The University of Michigan
Ann Arbor, Michigan

US-AID/AFR/C-1257
Dept. of Agricultural Economics
Purdue University
W. Lafayette, Indiana

Centre de Recherche
Economique Appliqué
Université de Dakar
Dakar, Sénégal

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Preface

This study of producer grain disposition was a joint effort by CRED University of Michigan (Grant: US-AID/csd 2547), Purdue University (Grant: US-AID/AFR-C-1257), and CREA University of Dakar. Appreciation for the direct funding of this study is extended to CRED and to Purdue University. Mr. Makhtar Diouf of CREA provided many supporting services for the project.

The interviewing of the farming families was coordinated with the Institut Sénégalais de Recherches Agricoles (ISRA) through their Centre National de Recherches Agronomiques (CNRA) at Bambey. Mr. Moussa Fall, Director of the US AID sponsored "Programme Moyen Terme Sahel/ cellule de liaison" at Bambey graciously made available his enumerators to collect the data on grain transactions which are analyzed in this report. These data were collected from July 1977 to June 1978.

Completion of the work in the United States was facilitated by Purdue University's preparing of the data for computer analysis with Dr. Margaret Saunders supervising this aspect of the work. David Jick from the University of Michigan was responsible for the computer analysis of the data set. Finally, helpful suggestions were received from Professors Elliot Berg and Richard Porter (CRED, University of Michigan) and Wilford Morris (Purdue University).

Clark G. Ross
CRED, University
of Michigan

June 1979

CHAPTER I

INTRODUCTION

To encourage economic development and food self-sufficiency, the Sahelian countries of West Africa have joined together in forming CILSS (Interstate Committee for the Fight against Drought in the Sahel).[1] CILSS has formed committees to study various aspects of the area's agricultural problems. One of these committees, Marketing, Price Policy, and Storage, commissioned the University of Michigan's Center for Research on Economic Development (CRED) to undertake a diagnostic study of food grain marketing and price policy in each of the CILSS states. The CRED study, released in August of 1977, succeeded in two respects. First, it provided basic descriptions of grain price policy, marketing activity, and storage capacity for each country. Second, the CRED study identified topics for which additional research is needed to resolve strongly contested issues.

These debated issues to a large extent revolve around the competitiveness of the Sahelian grain trade. Those stressing the lack of competitiveness in the current situation envision a marketing system dominated by large traders possessing monopsonic power over producers and monopolistic power over consumers with consequent low producer and high consumer prices. Proponents of this view of grain marketing argue for extensive state intervention, favoring schemes such as national marketing boards (with monopoly power and guaranteed prices) and national buffer stock or storage programs.

The CRED study found little empirical evidence to evaluate the competitiveness of grain marketing, because reliable micro-level data were not available. Obviously, studies of consumer, producer, and trader behavior are needed to clarify the issue.

A study concentrating on producer behavior was begun in Senegal in 1977. From July 1977 to July 1978 interviewers recorded all grain transactions (consumption, sales, purchases and other exchanges) for thirty families (ten families in each of three villages).[1] Ideally, the data collected should provide insight in the following key issues:

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[1] The Gambia, Senegal, Niger, Chad, Mali, Upper Volta, Mauritania, and Cap Vertian Islands.

A. Grain consumption of the peasant family.
B. Degree of self-sufficiency attained by the farmer.
C. The magnitude and timing of producer sales.
D. Outlets of sale or intermediaries used by the producer.
E. Prices received by the producer for his grains.

This study is organized as follows: Chapter II provides a description of Senegalese agriculture. Chapter III identifies the three villages used in the study and details the marketing alternatives available to producers in each village. Chapter IV summarizes the empirical findings, which are generally supportive of the competitive hypothesis, and attempts to interpret these results. Finally, Chapter V presents the study's major conclusions, relating them to Senegalese agriculture policy.

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[1] The services of the interviewers and names of families were kindly provided by Mr. Moussa Fall of CNRA Bambey.

CHAPTER II

THE SENEGALESE AGRICULTURAL SECTOR

This chapter attempts to provide the background information on Senegalese agriculture necessary for an understanding of this study. Included are sections describing production, marketing, and price policy.

Section 1 - Production

Of the 5.1 million Senegalese, approximately 70 percent live in rural areas, with agriculture as their primary activity. Groundnut production is the single most important agricultural activity, with most output being transformed to groundnut oil and exported. As a result of this specialization, Senegal had relied heavily on commercially imported foodgrains, particularly rice.

Groundnut hectarage has shown a fluctuating but upward trend in recent years, concurrent with increases in the producer price and resulting profitability of groundnuts. Production, varying with rainfall patterns, has ranged from 583,000 tons in 1970 to a high of 1,100,000 tons in 1975. The Groundnut Basin of Senegal, comprising the regions of Thiès, Diourbel, and the Sine Saloum, accounts for 80 percent of total groundnut production. The three villages followed in this study are all located in the Groundnut Basin.

Millet production, primarily destined for self-consumption, has varied from 322,000 tons in 1972 to 770,000 tons in 1974. In recent years a slight reduction in land devoted to millet production has occurred as peasants have increased factors allocated to groundnuts. Millet is grown throughout Senegal and is the prinicpal grain in the diet of most rural inhabitants.

Two other crops that are relatively important for Senegalese agriculture are rice and maize. Ambitious rice projects hope to increase production from the current 100,000 tons to 300,000 tons annually, eliminating rice imports, which currently average 200,000 tons per year. Maize production has remained relatively constant at 47,000 tons during the last four years.

Section 2 - Marketing

There are three principal groups involved in the marketing of agricultural products in Senegal. First, the governmental agency, ONCAD, (Office National de Coopération et d'Assistance pour le Dévéloppment) has a legal monopoly for the primary purchase of groundnuts and millet, as well as responsibility for the sale and distribution of agricultural inputs. Second, various regional development organizations, while primarily responsible for agricultural extension activity and the development of new lands, engage in commercial activities. Finally, the private sector is engaged in the marketing of millet, maize, and rice. A brief description of the marketing channels (in theory and in fact) for the two principal agricultural products, groundnuts and millet, now follows.

A. Groundnuts

ONCAD's monopoly appears to be effectively enforced, since it is the sole legal seller of groundnuts to the groundnut oil mills. Producers sell their groundnut crop to ONCAD groundnut cooperatives, which are present in all regions of Senegal.

The official producer price for groundnuts is announced in mid-November and the buying season generally begins in early December. Official producer prices for groundnuts, millet, and rice are recommended by an intragovernmental committee, Committee of Great Agricultural Products (CGPA).

B. Millet

The three forces previously described - ONCAD, regional development organizations, and private traders - are all involved in the marketing of millet in Senegal. Since its inception in 1966, ONCAD has been a purchaser of producers' millet. From 1964 until 1975 ONCAD acted in competition with a legal private sector.

In 1975 ONCAD was awarded a legal monopoly for the primary collection of millet. In principle, only ONCAD seccos or specially licensed traders would have the right to purchase millet from the producer. The Committee of Great Agricultural Products was empowered to establish prices and profit margins at each stage in the marketing process. Grain purchased by ONCAD would either be resold to licensed wholesalers for eventual consumer sale, sold to cooperatives in deficit areas, or used to establish a security stock.

The ONCAD monopoly was aimed at improving the marketing of millet from both the perspectives of efficiency and equity. ONCAD's hope was that in controlling the marketing of millet, the assumed excessive profits of the trader would be eliminated. In theory, there would be a higher producer price to the farmer and a lower final price to the consumer. Also, economies of scale in millet marketing were claimed; thus ONCAD's monopoly position would presumably lower intermediate costs. The monopoly was further defended in light of Senegal's perennial grain deficit and resulting rice imports. Higher producer prices were expected to stiumlate millet production, slowing the trend toward allocating additional resources into groundnuts. Further, a lower consumer price would increase millet consumption by the non-agricultural urban population, tending to reduce rice imports.

In the first year of operations following the reception of their monopoly, 1975/1976, ONCAD succeeded in purchasing only 12,125 tons, or 2 percent of the Senegalese millet production. These purchases were 23,844 tons less than those of the preceding year in which ONCAD and the private sector legally coexisted. During the 1976/1977 campaign, for which the official producer price was raised to 35 CFA/kg, ONCAD's purchases of millet further declined.[1]

Even those most sympathetic to ONCAD's monopoly position agree that the results have been far from satisfactory. To those in support of ONCAD's monopoly position, current purchasing problems are temporary, stemming from poor harvests and initial ONCAD inexperience.

Others less sympathetic to the monopoly position argue that the problems are more structural in nature and that ONCAD will never succeed in controlling the millet market. First, it seems ONCAD has little interest in enforcing its millet monopoly. The producer price of 35 CFA/kg coupled with a 43 CFA/kg resale price to approved traders leaves a margin on only 8 CFA/kg for ONCAD. This margin is insufficient to cover the costs of purchase, transport, storage, and resale.[1] Thus, the millet operation is done at a financial loss. Also, ONCAD does not facilitate millet purchasing, maintaining only thirty-nine seccos, or millet buying points.[2] A peasant is often ten or fifteen kilometers from the nearest secco.

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[1] A sharp increase in the producer price from 35 CFA/kg to 40 CFA/kg, as well as, a good millet harvest permitted ONCAD to purchase nearly 100,000 tons of millet in the 1978-79 campaign.

A question of more primary importance is whether ONCAD's millet operations must be performed at a deficit. Critics of the ONCAD monopoly argue that ONCAD has no legitimate market function to perform. In theory ONCAD purchases millet from the peasant at 35 CFA/kg and sells to an approved trader at 43 CFA/kg. Assuming that the private trader can reach the peasant and his millet as easily as ONCAD can, the private trader could offer the peasant an intermediate price, 40 CFA/kg, for example. In such a case, both the producer and the trader receive a better price.[3]

One of the questions investigated in this report is whether the private trader does in fact pay the peasant a price in excess of ONCAD's producer price (35 CFA/kg) but less than ONCAD's resale price (43 CFA/kg). In a competitive situation, the answer would be affirmative as trader competition would bid up the producer price from ONCAD's floor price. On an a priori basis, a number of factors suggest a strong degree of competition. First, traders must compete with the peasant's own need for food. Since the peasant's primary cash needs are met through the sale of groundnuts, the peasant is less obligated to sell millet.

A second reason to expect strong competition in millet marketing is the visible presence of large numbers of active traders in Senegal. The relatively small distance between major markets and producing areas as well as a relatively good transport infrastructure imply frequent contact between peasants and traders. This degree of competition would imply that price savings (as from avoiding ONCAD) or demand-stimulated price increases would be passed on to the producer by the traders.

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[1] SONED Study figures.

[2] In contrast to the 1800 groundnut purchasing cooperatives. During the 1978/79 campaign the number of millet buying points was greatly increased.

[3] ONCAD's difficulty in reselling millet purchased during the 1978/79 campaign indicates that traders do prefer dealing directly with the peasants.

Section 3 - Price Policy

As previously mentioned, Senegalese agricultural prices are officially set by governmental decree. The stated phiolosphy of the price committee is to set prices which promote (1) the agricultural objectives of the government, and (2) greater economic equity. Without considering possible conflicts within this dual objective, it is sufficient to realize that the Government of Senegal views the price-setting activities of the CGPA as a policy instrument. The fundamental issue however, is the degree to which the GOS can autonomously set prices which differ from market prices.

An important factor is the extent to which the market is controlled by the government. Naturally, a sole purchaser or sole seller of a product has greater ability to enforce controlled prices. In the case of agricultural products in Senegal, the Government effectively controls the purchase of groundnuts from the farmer and the sale of imported rice to traders. However, the government marketing board controls little of the domestic millet market, with the private sector handling the preponderance of millet.

Encouraging food self-sufficiency by increased local production of rice and millet is a stated objective, toward which price policy has been directed. The official prices for major products follow:

	1973-74	1974-75	1975-76	1976-77	1977-78
Groundnuts	25.56	41.5	41.5	41.5	41.5
Millet	25.96	30.0	30.0	30.0	35.0
Maize	25.00	35.0	35.0	35.0	35.0
Rice (Paddy)	25.00	41.5	41.5	41.5	41.5

CFA/kg

After the producer groundnut price increase in 1974, resources were channeled into the production of groundnuts, at the expense of millet. Consequently, the government in 1976 increased the official price of millet, leaving the groundnut price unchanged. Millet supply, however, was not greatly stimulated because groundnut production remained considerably more profitable than millet cultivation.

A relevant question is whether consumer demand could raise the free market price of millet to the point where its production would be more profitable than that of groundnuts. At the 41.5 CFA/kg price for groundnuts, an estimated producer price of 58-60 CFA/kg for millet is needed to induce the producer to shift resources from groundnuts to millet. Including all intermediate costs and margins, millet would have a cost price of 80-90 CFA/kg in Dakar. Currently, imported broken rice to which the Senegalese consumer has a strong preference sells for 80 CFA/kg. As long as rice is available at this price, consumer demand for millet in the food deficit urban areas will be limited.[1] In summary, food self-sufficiency is hindered by the same official price structure whose stated aim is to encourage food self-sufficiency. The official prices which have economic significance are the producer price for groundnuts and the consumer price for imported rice. At current levels both of these prices discourage food self-sufficiency, by encouraging specialization in groundnuts and importation of rice.

The feasibility of attaining self-sufficiency should be addressed. While there are short-run economic benefits to the current situation of specialization and trade, adverse (to Senegal) world price changes for groundnuts and/or rice could disrupt the Senegalese economy. A greater degree of food self-sufficiency as protection against devastating price changes may be desirable.

Basically, a price policy which diverges from world market prices may be needed. A decrease in the producer price for groundnuts, a tariff on imported rice, or some combination of the two should be considered. A decreased producer price for groundnuts would shift resources into millet production. A higher consumer price for rice could render locally grown rice economically feasible and also would stimulate demand for millet. The exact magnitudes of the groundnut price change and/or the rice tariff depend on the desired degree of food self-sufficiency and the underlying production and consumer demand functions. The short-run economic costs of pursuing food self-sufficiency are obvious. Producers receive a lower price for groundnuts; and, even with the higher price for millet, farmer income would fall.[1] Consumers would pay a higher price for rice and for millet. These costs must be weighed against the benefits of greater food self-sufficiency.

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[1] Further, the actual degree of substitutability between millet and rice in Dakar is unclear. Rice is primarily consumed at mid-day, while millet is exclusively consumed in the evening.

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[1] A particularly high tariff on imported rice could conceivably force the price of millet upward to the point where income for certain farmers actually increased. In this case the full burden of pursuing food self-sufficiency is being borne by the non-producing consumer of grains.

CHAPTER III

THE VILLAGES AND FAMILIES SURVEYED

This chapter describes the villages and the socio-economic characteristics of the families followed in this study.

Section 1 - The Geographic and Physical Setting of the Villages

The three villages used in this study are located in the Thiès-Diourbel region of the Groundnut Basin, the most important agricultural area of Senegal. The accompanying map locates the three villages. Got, with a population of 264, is seventeen kilometers southeast of Thiès through the village of Noto, within two or three kilometers of Got.[1] N'diamsil Séssene (population 305) is the most isolated of the three villages. Located about eighteen kilometers northeast of Khombole, access is provided by a network of sandy trails extending from the main dirt road connecting Khombole with Baba-Garage. This dirt road passes through Touba-Toul, an important weekly rural market. The final village, Layabé, is about twenty-three kilometers north of Diourbel. Access to this village of 380 inhabitants is provided by the main dirt road running from Diourbel to N'dindi.

As is evident from the map, each village is reasonably close to the main highway running from Dakar to Diourbel. This provides potential for an easy exchange of products and ideas between these villages and the urbanized Cap-Vert (Dakar) region. Agricultural products can be shipped from these villages toward the urban markets, and consumption goods can easily flow toward the villages.

Section 2 - Socio-Economic Characteristics of the Villages

All three villages are predominately Wolof in ethnic composition and Moslem in religious affiliation. N'Diamsil is regarded as the most traditional of the three villages and has the most religiously strict population. Got, near Thiès, and Layabé, near Diourbel, have greater exchanges with the less traditional urban population.

For the agricultural camapign of 1975-76, summary production and input

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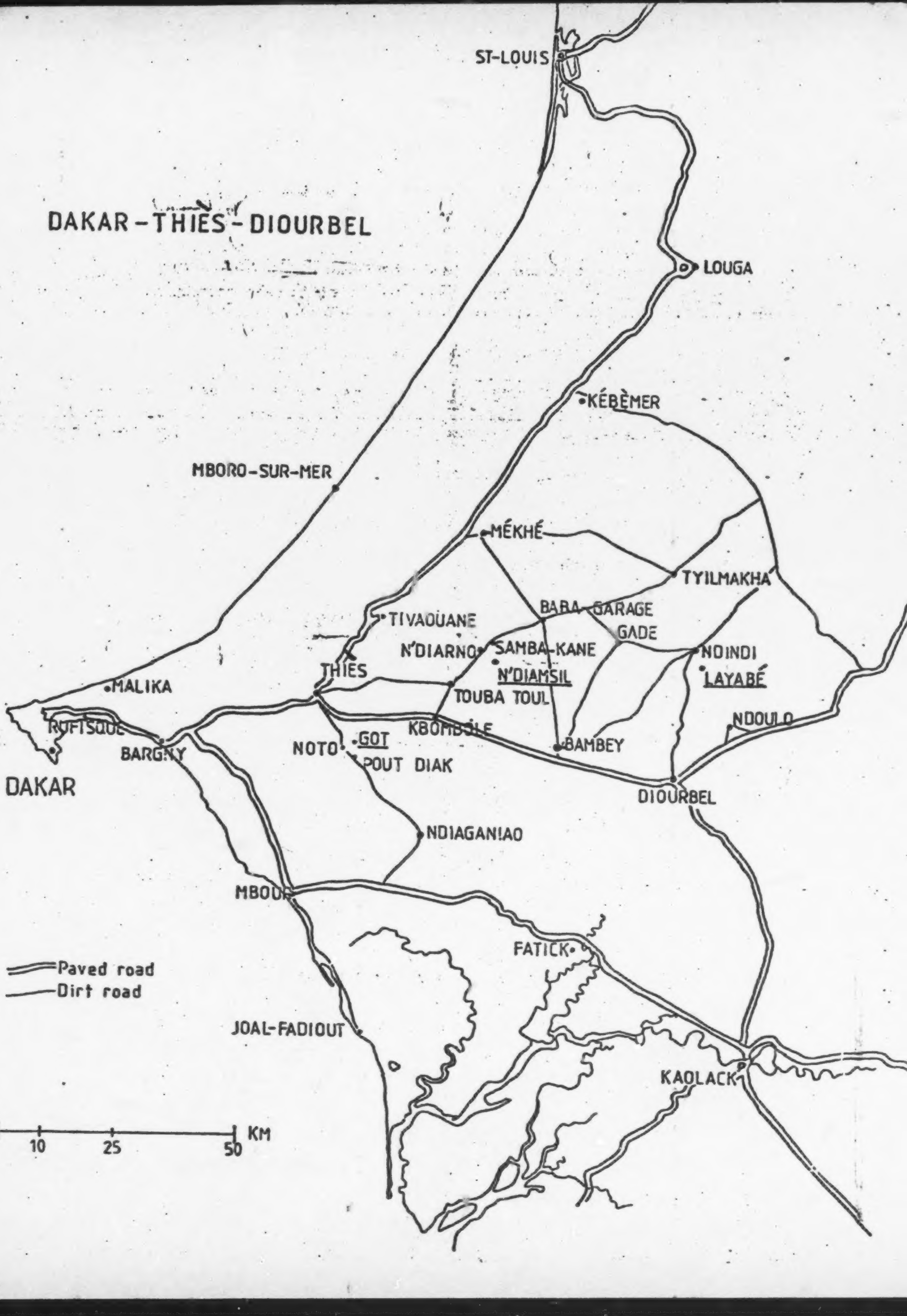
[1] All population figures are for 1976.



DAKAR-THIES-DIOURBEL

ST-LOUIS
LOUGA
KÉBÈMER
MBORO-SUR-MER
MÉKHÉ
TYILMAKHA
BABA-GARAGE
GADE
TIVAOUANE
N'DIARNO
SAMBA-KANE
N'DIAMSIL
NDINDI
LAYABÉ
THIES
MALIKA
TOUBA TOUL
RUFISQUE
BARGNY
KBOMBOLE
NDOULO
BAMBEY
NOTO
GOT
POUT DIAK
DAKAR
DIOURBEL
NDIAGANIAO
MBOUR
FATICK
JOAL-FADIOUT
KAOLACK
Paved road
Dirt road
10
25
50
KM

data were collected by CNRA at Bambey through interviews with ten families in Got, five in N'Diamsil, and ten in Layabé.[1]

Table I presents information on the average land surface area and working population by family for each village.

TABLE I
1975/1976

Village	Surface (ha.) Available	No. of Workers[a]	Surface Groundnuts	Surface Millet	Hectare / Workers	Surface Groundnuts / Surface Millet
GOT	11.31 (7.08)[b]	5.86	7.51	3.80	1.93 (0.59)	1.98
N'DIAMSIL	14.22 (7.20)	7.65	7.72	5.72	1.86 (0.29)	1.35
LAYABÉ	15.52 (0.86)	6.00	9.23	5.15	2.59 (1.11)	1.79

[a] The number of workers is calculated using effective working units which give the following weights for each age-sex classification: Man 1., Boy .5 (8-14 years), Woman .5, Girl .2 (8-14 years).

[b] When available the standard deviation is shown in parantheses.

Certain conclusions emerge from these data. First the average hectarage per farm in these villages is greater than that for Senegal as a whole. Secondly, in each village the surface devoted to groundnut cultivation is sginificantly greater than that devoted to millet cultivation, reflecting the greater profitability per hectare of groundnuts than of millet. In N'Diamsil the groundnut/millet surface ratio is the lowest. This is probably due to a greater desire for food self-sufficiency in this most isolated of the three villages.

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[1] In the following year the number of families was increased to ten in N'Diamsil.

Table II shows the degree to which families are self-sufficient in cereal needs for each village.

TABLE II

CEREAL PRODUCTION, 1975/1976

	Got	N'diamsil	Layabé
Family Millet Production	1039.4 kilo	2332.8	2366.5
Number of inhabitants[a]	12.6	14.8	11.1
Millet per inhabitant	82.5 kilo/person	157.6	213.2

[a] This is the actual number of people in the family as contrasted with the calculated number of workers used in Table I.

Assuming that 200 kilograms of unmilled cereals per person are necessary during a year, only in Layabé is the typical family self-sufficient. In Got the average family's production only covers 42 percent of assumed grain needs. Income earned from groundnut production and from off-season economic activities permit the families of Got to purchase a larger proportion of their grain. In N'Diamsil, even though it was shown that families devoted a greater proportion of their exploitable land to cereal crops than in the other villages, the typical family was only 79 percent self-sufficient in cereals. In Layabé, even though the typical family was self-sufficient in cereals, four of the ten families harvested less than 200 kilograms per person.

Section 3 - The Typical Agricultural Exploitation

The purpose of this section is to familiarize the reader with the decision-making process found in the Wolof type agricultural exploitation in Senegal.

This discussion primarily draws on work by Paul Kleene.[1] He claims the exploitation revolves around the carré (compound), whose principal fields are directed by the chef (leader) and whose secondary fields are worked by the men and women dependent on the chef for their food. These dependents include the leader's wives, children, nephews, brothers, and even hired "strange" farmers.[1]

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[1] The description presented in this section is drawn from Kleene: "Notion D'Exploitation Agricole et Modernisation en Milieu Wolof Saloum", L'Agronomique Tropicale XXI-1, Janvier-Mars 1976.

At the beginning of the agricultural campaign the leader assigns each woman and man over fifteen years of age at least one parcel of land to cultivate groundnuts. The leader usually reserves for himself the cultivation of millet on fields close to the compound, in recognition of his obligation to feed his dependents. Agricultural material, both equipment and animal, is under the control of the leader. Seeders, some type of animal traction for land preparation, and weeding equipment are used to varying extents by most of the producers in this study.

After the harvest, the year's crops are at the disposition of the leader. He must first repay his groundnut seed debts to the ONCAD secco and then sell his groundnut crop. A portion of these receipts will be given to each exploiter of a field, with the leader retaining a portion for lodging and food expenses. Depending on his cash position (need for money), his perception of price trends, and the available market outlets, the leader considers the timing of his millet sales. However, no *a priori* decision rule concerning the disposition of the farmer's millet can be advanced. Millet cultivation is primarily viewed as a direct food source for the family, but significant amounts are devoted to other uses (sales, baptisms, repayments, loans, gifts). This empirical study tries to identify the magnitudes of these other uses.

Section 4 - Market Alternatives

This section will describe the marketing outlets available for residents of each village. A description of the different possibilities for grain disposition is first presented.

1. Consumption - A large portion of the millet grown is self-consumed by the producer.
2. Gifts - Gifts of millet for religious festivals or charity are common.

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[1] The strange farmer is a migrant worker who spends the agricultural season with a host farmer. While working on the leader's fields, he also has certain rights to cultivation.

3. Loan Reimbursements - Common within a village are temporary transfers/loans of millet or rice.
4. Purchase -
   - a. Rice - Within the village there are small boutiques selling rice; also, farmers have access to rural and urban markets.
   - b. Millet - Farmers in need of millet can usually find a villager willing to sell small quantities.
5. Sale -
   - a. Groundnuts - The crop is delivered by the producer to a groundnut cooperative -- at most, two or three kilometers from the village, if not in the village. Prior to the sale of his product, the farmer is obligated to repay his groundnut seeds at an ONCAD *secco*.
   - b. Rice - The producers in this region do not cultivate rice.
   - c. Millet - The farmer has many options for the sale of millet.
     - i. ONCAD - The legal purchaser of millet is the ONCAD secco in the producer's area, offering the farmer the official producer price; 35 CFA/kg (1977/1978).
     - ii. Neighbor in the village.
     - iii. Village collector - Often within the village a small storekeeper will purchase millet in small quantities (3-10 kg) from producers and collect this millet in larger sacs for eventual resale to rural traders. This system gives the producer an ever present outlet for small quantities of millet. Often, the cash he receives is spent in the same store for rice, oil, or other goods.
     - iv. Rural collector - Traders visit the village to purchase millet either from the producer or village collector. This rural collector primarily supplies urban millet sellers.
     - v. Rural market - The producer may take millet to the rural market in his area. These markets are usually weekly events, attracting large numbers of buyers and sellers.

vi. Urban inhabitant - Often an urban dweller will visit a village accessible from the highway to purchase millet.

In principle options ii - vi are illegal, due to the official monopoly role given to ONCAD.

6. The use of millet for seed and for animal feed has been noted by the interviewers and included in the statistical results.

The specific marketing options associated with each village are now detailed.

A. Layabé

The following commercial circuits can be identified for the inhabitants of Layabé. (See Map: Chapter III, Section 1)

Rice: Generally, rice is purchased within the village but a wide variety of imported rice can be found about twenty-five km south of Layabé in Diourbel.

Groundnuts: Within the village there is a groundnut cooperative; repayment of the seed debt is made at the secco located in Diongo, three kilometers west of Layabé.

Millet: a. Official Channel - the ONCAD secco located in Diongo is the presumed locality for the sale of producer's millet to ONCAD. Transport between the village and the secco is easily found; the normal charge is 100 CFA for a cart with a horse or one CFA/kg for 100 kgs. The Layabé producer can sell to ONCAD with a minimum of inconvenience and expense.

b. Parallel Market - Rural traders frequently visit the village to purchase millet, or millet is sold at Tyilmakha, an important rural market.

B. N'Diamsil

The following commercial circuits can be identified for the inhabitants of N'Diamsil.

Rice: Rice can be purchased from a village boutique. The consumer can find a wider selection of rice at a weekly rural market -- Touba Toul (Saturday) or Samba Kané (Tuesday).

Groundnuts: A producer cooperative is located in Samba Kané, about five kilometers from N'Diamsil, and another cooperative is in Ndiarno, about four kilometers from N'Diamsil. Transport charges to both cooperatives by horse and carriage are 150 CFA per 100 kilograms or 1.5 CFA/kg. The secco serving the N'Diamsil population is located at Samba Kané where seed debts are repaid.

Millet: a. Official Channel - The ONCAD secco at Samba Kané.

b. Parallel Market - The peasant often sells larger quantities of millet at the weekly market at Touba Toul, since prices are more attractive than those prevailing in the village. The average transport charge from N'Diamsil to Touba Toul is only one CFA/kg of millet. As indicated on the map, only eight kilometers of a relatively good dirt road separate Touba Toul from the main Dakar-Thiès-Diourbel highway. Thus, many traders and inhabitants of Thiès and Dakar attend this market.

C. Got

The following commercial circuits can be identified for the inhabitants of Got.

Rice: Rice is either purchased locally in village boutiques or in Thiès if larger quantities or scarcer varieties are sought.

Groundnuts: The residents of Got can use cooperatives located in Noto (two km away) and Pout Diak (five km away). The secco for the repayment of groundnut seed is in Noto.

Millet: a. Official Channel - The ONCAD secco for the sale of millet is conveniently located in Noto.

b. Parallel Market - Got producers can sell millet at village boutiques or in the neighboring markets of Noto and Pout Diak, or in the urban Thiès market. Even within the village there is demand for millet since the typical Got family is not self-sufficient in millet.

CHAPTER IV

ANALYSIS OF GRAIN TRANSACTIONS

This chapter will present the empirical findings from the study of grain transactions in the three villages. Production, consumption, purchases, sales, and other transactions will be reviewed in separate sections. A concluding section will summarize these results.

To avoid confusion with the annual identification of data items, a brief review of the chronology of this study is in order. The enumerators began recording household grain transactions in July 1977 and terminated in July 1978, after one full year. Data items collected during this time period will be referred to as 1977/78 data. Production and input usage data are collected for an agricultural year - planting occurring in June with a harvest in late November. These data will be identified by a single annual notation - 1977 refers to crops planted and harvested in 1977. Obviously, the grain dispositions noted by the enumerators are from both the harvests of 1976 and that of 1977.[1]

Section 1 - Compound Production

The data presented in Table I, detailing hectarage, production and yields per hectare for the typical compound in each village differ slightly from those presented in Chapter III-2 for the agricultural year 1975. Between 1976 and 1977 there is a slight decrease in the mean total hectarage per compound, in all villages except Layabé. More striking is the dramatic fall in groundnut production from 1976 to 1977; the mean sample yield/hectare for groundnuts fell from 1033 kg to 345 kg. This is primarily due to the absence of rains in late June and early July 1977 when groundnuts were being planted.

On a per capita basis, millet production ranged from 111 kg in Got in 1977 to 358 kg in N'Diamsil in 1976. The discussion (Chapter III-2) of the 1975 socio-economic base data assumed a 200 kilogram per capita

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[1] Also, grain stored from previous harvests could be included.

TABLE I

MEAN COMPOUND PRODUCTION STATISTICS

VILLAGE ITEM	GOT	N'DIAMSIL	LAYABE	TOTAL SAMPLE
1. No. Actives 1977	5.2	6.0	5.5	5.6
2. Ha Millet 1977	4.07	4.91	6.10	5.06
1976	4.48	5.53	5.50	5.10
3. Ha Groundnuts 1977	6.72	5.04	7.36	6.37
1976	7.70	6.15	7.53	7.11
4. Total Ha 1977	10.79	9.95	13.55	11.43
1976	12.18	11.68	13.03	12.30
5. Production Millet 1977	1222	3655	4015	2964
(kg/compound) 1976	1962	4830	2470	3126
6. Production Groundnuts 1977	1930	1134	3534	2200
(kg/compound) 1976	5801	6332	9757	7348
7. Yield Millet 1977	300	744	649	586
(kg/ha) 1976	438	873	449	602
8. Yield Groundnuts 1977	287	225	480	345
(kg/ha) 1976	753	1030	1296	1033
9. Ha/Active 1977	2.08	1.66	2.46	2.05
10. Population 1977	11.0	13.9	11.6	12.2
(per compound) 1976	11.8	13.5	11.6	12.4
11. Millet Production 1977	111	263	246	243
(kg/capita) 1976	166	358	213	252
12. Surface Groundnuts ÷ Surface Millet 1977	1.65	1.03	1.10	1.26
1976	1.72	1.11	1.37	1.37
13. Value of Groundnut Crop 1977	$341	$200	$624	$389
1976	$1025	$1118	$1723	$1298

[a] There were 10 household compounds in each village, a total sample of 30 compounds, except for Got which only had 9 in 1976.

[b] The value of groundnuts is calculated at the official price of 41.5 CFA/kg, (41,500 CFA/ton) approximately $176.60/ton at 235 CFA/$.

annual grain requirement for the population. Assuming 10 percent milling losses this requirement is equivalent to an annual consumption of 180 kilograms of cereals.[1] Thus, in both 1977 and 1976, the mean sample compound produced in excess of its annual nutritional needs.

More specifically, Table II shows the number of compounds in each village which produced in excess of 200 kilograms per capita in 1977 and 1976.

TABLE II

NUMBER OF COMPOUNDS IN EXCESS OF 200 KG OF MILLET PER CAPITA

	GOT	N'DIAMSIL	LAYABE	SAMPLE
1977	2	8	10	20
1976	3	10	8	21

(a) In Got during 1976 only 9 compounds were followed; all other villages had 10. Thus the sample size for 1976 is 29 and that of 1977 is 30.

Consistent with the village means shown in Table I, in thirty-six of the forty cases (1976-1977) the compounds of N'Diamsil and Layabé produced in excess of 200 kg per capita. In Got, however, only five of the nineteen compounds met the consumption requirement. The smaller hectarage per compound devoted to millet in Got as well as substantially lower millet per hectare yields cause this shortfall in Got. Nearly all compounds in N'Diamsil and Layabé are capable of meeting their full grain needs with their own production. As will be shown in the next section, however, most compounds in these villages elect to diversify their diet by purchasing rice.

Groundnuts, as previously discussed, are nearly entirely sold to the local ONCAD cooperative at the official price of 41.5 CFA/kg. As can be seen from Table I, mean compound groundnut production fell by 70 percent from 1976 to 1977. Since the cash income position of farmers would have been correspondingly adversely affected, there may have been greater inducement for the farmer to sell millet, recouping that income lost from groundnuts. This influence should be considered when evaluating the millet sales decision.

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[1] The Gambia River Basin Development Committee has posited 182.5 kg of milled grains as the annual per capita requirement.

Section 2 - Consumption of Grains

Table III summarizes the recorded annual grain consumption of the sample households.

Certain points merit discussion. First, the recorded levels of annual per capita grain consumption for N'Diamsil and Layabé approached the standard of 180 kilograms of milled cereals. In Got, however, the annual per capita grain consumption is significantly lower, 128 kg.[1] There is no obvious explanation for this discrepancy. Per capita rice consumption in Got, as expected, was significantly greater than in the other two villages. The consumption deficit in Got is primarily in millet of which the per capita consumption is only 87 kilograms. Since the 1977 millet harvest in Got was substantially below that of 1976, reduced millet consumption should be expected. This decreased millet consumption should theoretically be replaced by increased rice consumption. Nevertheless, the calculated statistics, if correct, indicate a grain deficit for the inhabitants of Got.[2]

The percentage of millet in the household diet is highest in N'Diamsil -- the most isolated and traditional village. In Layabé, rice plays a more important role, accounting for 16.2 percent of annual grain consumption. The financial position of the Layabé farmer, with his importat groundnut production, permits him to purchase rice and other foods more easily. This observation is germane to the general question of food self-sufficiency in in Senegal. Growing urbanism and rising farm incomes will probably lead to increases in rich purchases as the rural population attempts to diversify

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[1] Each of the per capita annual consumption estimates are biased downward since the compound population has not been adjusted for any dry season out-migration. This is particularly important in Got, where younger compound members often go to Dakar or Thiès in search of off-season employment

[2] Of course, the greater accessibility to fresh vegetables, fruits, and fish by the population of Got reduces somewhat the quantity of grains needed.

TABLE III

ANNUAL HOUSEHOLD GRAIN CONSUMPTION, 1977/1978

Item/Village	Got	N'Diamsil	Layabé	Sample
1. Compound Millet Consumption, kg	920	1893	1620	1477
2. Compound Rice Consumption, kg	448	180	309	312
3. Total Compound Grain Consumption, kg	1368	2073	1929	1789
4. Population/Compound	11.0	13.9	11.6	12.16
5. Millet/Capita, kg	87	160	150	132
6. Rice/Capita, kg	41	14	29	28
7. Grains/Capita, kg	128	174	179	160
8. % of Millet in Total Grain Consumption	66.8	91.6	83.8	80.7
9. Compound Millet Production (1976, 1977 mean), kg	1592	4243	3243	3045
10. % of Mean Production Consumed	58%	45%	50%	49%

its diet. In this case, rice imports, unless offset by domestic paddy production, would tend to increase more rapidly than expected.

Another point of importance is the large estimated compound surplus of millet in N'Diamsil and Layabé. Such excesses are available for either sale, gifts, or inter-annual storage. Of interest is the fact that even possessing large excesses of millet, compounds in N'Diamsil as well as in Layabé, regularly purchased rice to diversify their diets.

A final point is the absence of maize consumption by the households. Maize cultivation, however, was successfully introduced during the 1978 agricultural season in N'Diamsil to provide the farmer with another potential source of income. Maize promotion is laudable since it could help limit the growth of rice in the rural diet.

The purchase and sales decisions for grains will be more carefully examined in the succeeding sections.

Section 3 - Purchase of Grains

This section will examine the sample compound's purchase of rice and millet.

A. Rice Purchases

All survey compounds consumed rice to varying degrees. Because none of the compounds are rice cultivators, all rice consumed originates from external sources. The only meaningful source of rice for the household is through purchase, so, as expected, the mean quantity of rice purchased by the compound is nearly identical to mean compound rice consumption. These figures are shown in Table IV.

Second, households purchase rice frequently. The mean annual number of purchases for the typical household was 36.8, representing a purchase every ten days. The mean purchase, 8.3 kilograms, is small, showing that households purchase rice for immediate needs. Table V details rice purchases by weight. For the entire sample, nearly 90 percent of all rice purchases weighed ten kilograms or less.

Rice is usually purchased from small boutiques or stores located in each village. Such an arrangement facilitates credit, negates any transport cost or inconvenience, and permits a near bartering of millet for rice.

TABLE IV

ANNUAL RICE PURCHASES, 1977/78

Group/ Village	Compound Rice Consumption (kg)	Per Capita Rice Consumption (kg)	% of Rice in Grain Diet	Compound Rice Purchases (kg)	Mean Number of Purchases by Compound	Size of Mean Purchase (kg)	Mean Price CFA/kg	Annual Rice[1] Expediture CFA/Compound
Got	448	41	33.2	432	41.5	10.4	85.5	37,048
N'Diamsil	180	14	8.4	168	24.4	6.9	95.1	15,515
Lavabé	309	29	16.0	316	44.5	7.1	89.9	28,240
Sample	312	28	19.3	305	36.8	8.3	90.1	26,934

[1] Household rice expenditure is not exactly equal to household purchases x mean price since the mean price is a simple and not a weighted mean.

TABLE V

RICE PURCHASES BY WEIGHT

Weight (kg)	No. of Purchases	Percentage
0-9	893	79%
10-19	187	17%
20-49	29	2%
50 +	24	2%
Total	1133	100%

Mean purchase 8.3 kilograms

For the entire sample, 1007 or 89 percent of all rice purchases were from small village shops. There were 72 purchases from rural markets (primarily by N'Diamsil residents) and 31 purchases from urban markets (primarily in Thiès by Got residents). The remaining 23 purchases were either from neighbors or from rural traders who possessed a rare or high quality rice.

As suggested by Table IV, official rice prices differ in each of the villages, representing legal transport margins. The slight variations from the mean prices paid and official prices (CFA/kg, 85.5 vs. 85; 95.1 vs. 95; and 89.9 vs 90) can be due to households' purchasing in other markets, a discounting for larger purchases, or a premium for higher quality or scarcer rice. Mean household rice purchases are negatively correlated with the rice price for the three villages. It had been previously stated that Got residents perhaps consumed larger quantities of rice due to their proximity to an urban center, Thiès. The controlled rice price, however, is lowest in Got, also stimulating rice consumption to some extent.

The mean annual compound rice expenditure was 26,934 CFA, or $144.61 (235 CFA/$); this represents approximately 9 percent of the typical compound's 1976 groundnut income.

Often it is claimed that rice purchases result from compounds' exhausting their supply of millet. The hypothesis is that rice purchases increase sharply in June or July, continuing at a high level until the November harvests. For the sample group rice purchases did not show marked seasonality during the year. For N'Diamsil and Layabé it was not possible to reject the hypothesis of an equal monthly mean number of purchases. In Got, the hypothesis of equal means could be rejected; during the months of February-June 1978, mean rice purchases were in excess of those predicted. The primary reason for this was the poor millet harvest in Got of November 1977. The normally millet-deficient Got compound found itself with an even greater millet shortage. Thus, rice purchases were increased beginning a few months after the harvest.

The lack of seasonality of rice purchases in N'Diamsil and Layabé support the hypothesis that rural families purchase rice to diversify their diets. Compounds in these two villages had per capita millet production in excess of 200 kilograms, yet they voluntarily chose to supplement their diet with rice.

B. Millet Purchases

Since all of these compounds are millet producers, millet sales rather than millet purchases are more common. Eight of the thirty households, however, reported millet purchases in excess of 100 kilograms. These households with their annual consumption and 1977 production are listed in Table VI.

In Got, all households purchasing millet had millet production deficits with respect to their estimated annual millet consumption. These households purchased millet following the poor 1977 harvest.

In N'Diamsil the situation was slightly different, with two of the millet purchasers possessing large production surpluses. An explanation for this is that the 1977 groundnut harvest was particularly unfavorable in N'Diamsil. Some farmers with immediate cash needs were obliged to sell millet, since their anticipated groundnut income was not available. Other farmers in more favorable financial circumstances were willing to purchase millet from these cash-poor farmers, hoping to resell this millet at higher prices later in the year. This perhaps accounts for the purchase of millet by the three surplus compounds in N'Diamsil. No compounds in Layabé reported significant (>10 kilograms) millet purchases.

Section 4 - Sale of Grains

This section will present summary statistics for the sample compounds' selling of millet. Rice sales are unimportant since none of the sample compounds are rice cultivators. After first presenting summary statistics for millet sales, a more detailed interpretation/analysis of these results will be undertaken.

A. General Findings

Table VII indicates that twenty-five of the thirty compounds recorded millet sales during the July 1977 to June 1978 period. Only in Got, where compound millet production was low, were sales limited. The mean for the entire sample was 5.8 sales per year, but with a relatively large coefficient

TABLE VI

MILLET PURCHASES, 1977/78
(PER COMPOUND)

COMPOUND		Millet Purchases (kg)	1977 Millet Production (kg)	Estimated Annual Consumption (kg)	Estimated Surplus (+) Deficit (-) (kg)
Got	1	100	280	778	- 498
	2	250	327	924	- 597
	3	263	440	466	- 26
	4	247	204	484	- 280
N'Diamsil	5	135	7443	4282	3181
	6	170	1164	1206	- 42
	7	500	2935	1555	380
	8	220	3478	1425	2053

TABLE VII

MILLET SALES DATA 1977/1978

	GOT	N'DIAMSIL	LAYABE	SAMPLE
1. Number of compounds selling millet	6	9	10	25
2. Number of compounds selling millet more than 5 times	1	6	8	15
3. Mean number of sales/ compound	1.9	7.4	8.0	5.8
4. Mean weight sold/ compound (Kg)	194	309	306	270
5. Mean number of sales/ compounds selling millet	3.2	8.2	8.0	6.9
6. Mean weight sold/compound selling millet (Kg)	324	343	306	323
7. Weight of mean sale (Kg)	101	42	38	47
8. Total number of sales	19	74	80	173
9. Mean Price (CFA/Kg)[a]	43.2	33.7	36.0	35.8
10. Weighted Mean Price (CFA/Kg.)[b]	43.9	38.9	35.9	38.9
11. Mean revenue/compound selling millet (CFA)	14,224	13,343	10,985	12,565
12. Mean value of 1976 & 1977 groundnut crop (CFA ($))	160,505 ($683)	154,865 ($659)	275,773 ($1,174)	198,223 ($844)
13. Mean 1977 compound millet production	1222	3655	4015	2964
14. Percentage of crop sold (4 ÷ 13)	16	9	8	11

[a] Mean price per sale of millet

[b] Mean price of millet weighted by the quantity of the sale

of variation.[1]

On average those compounds selling millet sold 323 kilograms, with little variance among villages in this mean quantity. The mean quantity per sale was 47 kilograms.

Compared to 1977 millet production, sales per compound were a small percentage of total production, varying between 8 and 16 percent. This range is consistent with the aggregate estimates of millet marketing in Senegal. A national harvest of 554,000 tons in 1976 provided an estimated 55-65,000 tons of marketed millet, 10-12 percent of production.

While the mean millet price per transaction was 35.8 CFA/kg, the weighted mean price was higher at 38.9 CFA/kg. This indicates that farmers sold disproportionately larger quantities at higher prices. Both means exceed ONCAD's official price of 35 CFA/kg.

Got, because of its proximity to the millet deficient urban areas of Thiès and Cap Vert, reported the highest mean prices. In N'Diamsil the difference between the simple mean and the weighted mean price is noteworthy. This differential results from the fact that larger sales generally occur at the weekly rural market of Touba Toul where traders from Dakar and other urban areas are present. On the other hand, many sales of small quantities of millet (less than twenty kg) are made to small storekeepers within the village. Prices for these sales are lower but the farmer has the convenience of finding an immediate outlet for his millet. He then can purchase rice or other products from the storeowner. In fact, for residents of N'Diamsil, the closest ONCAD marketing secco is at Samba Kané, to which 1.5 CFA/kg of transport expense is generally paid. Thus, even ONCAD's official price of 35 CFA/kg is effectively less interesting for the N'Diamsil farmer than the 33.7 CFA/kg simple mean price. In Layabé, the two mean prices were nearly identical. In summary, the mean millet price was slightly in excess of ONCAD's official price. This casts doubt on the hypothesis that the farmer is obliged to sell large quantities of millet at depressed prices directly following the harvest.

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[1] This can be more clearly seen by the fact that for the fifteen households reporting more than five sales during the year, the mean was 9.9 sales. For the ten households selling millet less than five times per year, the mean was only 2.4 sales.

As can be seen by comparing revenues from millet to those from groundnut sales, the former are relatively unimportant. The following subsections address (B) the timing of sales, (C) intra-annual price variation, (D) intermediary, (E) pre-harvest contracting of millet, and (F) a modeling of millet sales.

B. Timing of Sales

Table VIII shows the number of millet sales recorded in each month.

TABLE VIII

FREQUENCY OF MILLET SALES 1977/78

		1977						1978					
	Total	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June
Got	19	1	2	1	4	6	0	2	0	3	0	0	0
N'Diamsil	74	4	1	3	7	2	13	15	12	5	7	5	0
Layabé	80	3	14	2	5	7	5	8	9	7	13	8	0
Sample	173	8	17	6	15	15	18	25	21	15	20	13	0

Sales are not evenly spaced over the agricultural year. Most sales (114, or 66 percent) are in the six post-harvest months, November-April. Nevertheless, these data do not support the contention that the farmer is obliged to sell millet directly after the harvest. Sales are reported throughout the year and, more importantly, sales are divided over the six month post-harvest period.

In a separate questionnaire the producers had responded that they sell millet:

1) As money needed	23
2) When the price rises	6
3) No response	1

No respondent during the sample period cited the selling or contracting of millet to traders before the harvest.

C. Intra-annual Price Variation

Table IX traces the course of producers prices over the twelve-month period, with the frequency of sales by price for each month shown.

TABLE IX

PRODUCER PRICE FREQUENCY 1977/78

		1977						1978					
CFA/Kg	Total	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
< 29	1	1	0	0	0	0	0	0	0	0	0	0	0
30-34	51	1	1	1	1	1	12	14	12	4	4	0	0
35-39	78	1	2	1	8	8	6	7	9	8	16	13	0
40-44	22	1	10	1	0	0	0	2	1	1	0	0	0
45-59	15	3	1	1	6	6	0	2	0	2	0	0	0
50-54	6	1	3	2	0	0	0	0	0	0	0	0	0
Total	173	8	17	6	15	15	18	25	21	15	20	13	0
Simple Mean	35.8	40.0	40.8	43.	36.7	38.9	31.7	33.5	33.9	35.5	34.5	35.3	-

Using a Chi-square test for equality of the means, it is possible to reject the hypothesis of equal monthly prices. Lower prices (35 CFA or less) tend to be concentrated during the post-harvest months of December-April. Higher prices (35 CFA or more) are more generally found in the May-November period.

More specifically, the lowest monthly mean price is 31.7 CFA/kg in December, directly following the harvest. Prices then begin to rise, reaching a maximum in September. As early millet becomes available in October and the November harvest is anticipated, prices begin to fall.

While the 31.7 CFA/kg millet price is significantly below the mean price for the sample, it should be noted that only 18 sales (10 percent) occurred in December.

Since this December price is below the ONCAD official price, even considering a typical transport charge of 1-1.5 CFA/kg. from a village to an ONCAD secco, it is reasonable to speculate why sales to ONCAD do not occur during this period. The primary reason is that the ONCAD seccos are not opened for millet purchasing until a few weeks after the harvest. The first priority for the seccos is to organize the repayment of producer groundnut debts which can be a one or two month operation. Following this, millet purchasing begins; however, prices on the parellel market start to exceed those of ONCAD. Assuming the price data presented here is typical, ONCAD could succeed in purchasing millet directly after the harvest as the official price of 35 CFA/kg would then be attractive.[1]

Often it is claimed that seasonal price differentials are sufficiently large for traders to realize excessive profits by storage and resale. Purchasing millet in December and reselling in September or October is the behavior ascribed to these traders. Using the price differentials shown in Table IX, the annual percentage return (r) for a trader purchasing (Dec.) and reselling (Sept.) millet within the rural area would be:

$$1. \quad 43 - \left(SC \cdot \frac{N}{12}\right) = 31.7 \left(1 + r\right)^{\frac{N}{12}}$$

or

$$2. \quad r = \left[\frac{43 - SC \cdot \frac{N}{12}}{31.7}\right]^{\frac{12}{N}} - 1$$

where SC = annual per kilogram storage expense; N = months.

SONED estimates annual storage costs at 5000 CFA/ton while Kohler estimates storage costs at 13,000 CFA/ton.[2] At a storage cost of 9000 CFA/ton, the simple mean of these estimates, a trader's annual return from millet operations would be 19.5 percent. While these calculations are at best indicative, they do not show that excessive profit margins (100-200 percent) are generated by exploiting intra-annual price differentials.

Seasonal millet price behavior appears to be consistent with that predicated by a competitive hypothesis. Prices gradually rise after the harvest, then begin to fall as the next harvesting begins. The annualized rate of return from speculating on seasonal price variations does not support the hypothesis of uncompetitive price behavior.

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[1] For 1978 ONCAD did succeed in organizing its millet purchasing at harvest time; as a result, estimated millet sales to ONCAD were significantly higher than those reported for the 1977 harvest.

[2] Kohler, Daniel, "Storage of Food Grains in the Sahel", unpublished USAID Report, 1978.

D. Intermediary

Of interest is the intermediary, or party to whom millet is sold. Table X indicates to whom millet was sold in each village.

TABLE X

INTERMEDIARY FOR MILLET SALES

	Got	N'Diamsil	Layabé	Sample
Village Store	1	28	22	51 (30%)
Rural Trader	15	14	55	81 (47%)
Neighbor	3	6	2	11 (6%)
Rural Market	0	25	1	26 (15%)
ONCAD	0	1	3	4 (2%)
TOTAL	19	74	80	173 (100%)
(percentages)				

The two most common sales outlets were the village store and the travelling rural trader, with 77 percent of all sales involving these parties. ONCAD benefited from only four sales, three of which were by Layabé residents. Certain inter-village differences emerge. In Got, residents dealt primarily with the travelling rural trader or assembler. In contrast, the less accessible N'Diamsil residents either sold to the village assembler or went to the rural market at Touba Toul. Traders are less likely to visit the small, inaccessible villages in the N'Diamsil area, preferring to attend the Saturday market at Touba Toul. Layabé residents relied more on the visiting rural trader.

Statistically, it was possible to reject the hypothesis of no relationship between sales weight and intermediary used for the villages of N'Diamsil and Layabé. Sales of larger quantities of millet (exceeding twenty kg) tended to be concentrated with rural traders (Layabé) or at a rural market (N'Diamsil).

In both villages most smaller sales (less than twenty kg) were transacted at the small village stores.

The above observation for N'Diamsil is consistent with the reported differential between the simple and weighted mean millet prices in that village. Sales of larger quantities of millet, while less frequent than sales of smaller quantities, occurred primarily at the rural market, Touba Toul, where prices were more attractive. The relatively more frequent sales of smaller quantities generally occurred at the village boutiques where prices were slightly less attractive, but where transaction costs are zero.

From the summary of the intermediary used, certain conclusions emerge. First, farmers have many viable alternatives which can be used for millet sales. The hypothesis of a competitive millet market is supported by this observation. While the degree of competition within each market outlet has not been established, the physical existence of many village stores, numerous traders at rural markets, and many travelling traders does suggest that competition is intense, both among and within the sales' outlets. Second, the preferred sales outlet(s) for village residents seems to vary, primarily with the accessibility of the village and its proximity to a major rural market. Finally, only 2 percent of the total sales involved ONCAD, the only legal purchaser of millet.

The sample farmers mentioned various reasons for avoiding ONCAD; as shown in Table XI.

TABLE XI

REASONS FOR AVOIDING ONCAD

Price Too Low	7
Delay or Lack of Payment	9
Inaccurate Weight	4
Other	5
Never Sell Millet	5

Seven of the respondents cited ONCAD's price as being too low. The other complaints concern administrative deficiencies on the ONCAD purchasing program, which could presumably be corrected with increased administrative efficiency. Since the weighted mean price per sale was 38.9 CFA/kg, or 11 percent above ONCAD's official 1977/78 producer price (35 CFA/kg), the ONCAD pricing problem is perhaps more relevant than indicated by the producer responses. The fundamental question of whether ONCAD can offer a price competitive with the private trader is still relevant. The empirical evidence, showing the lack of sales to ONCAD and the high frequency of producer prices in excess of ONCAD's official price suggests that ONCAD's role in millet marketing, except immediately after the harvest, may be difficult to establish.[1]

E. Pre-harvest Contracting of Millet

In this discussion of millet marketing, it was stated that during the time frame of this study, no compounds borrowed money from traders before the harvest with an agreement to repay millet following the harvest. Since this phenomenon at effectively usurious interest rates has often been cited, further investigation was decided upon.

Responding to the question asking from whom they had borrowed money during the year, sixteen of the seventeen compounds with reported borrowings cited a friend/neighbor.[2] In only one of these cases was the repayment in excess of the loan (850 CFA with 1000 repaid). All were short-term loans of less than six months duration. The general rule with respect to cash shortages is that farmers attempt to find more liquid neighbors or friends from whom they can borrow. These friends, either because of social mores or the potential need or reciprocity, do not usually charge any interest.

To explore more fully the often cited phenomenon of farmer's borrowing from traders with the promise to repay millet following the harvest, producers were asked to state such incidents during the last two years.[3]

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[1] Even if ONCAD establishes a major role as a purchaser of millet, the problem of resale must still be considered.

[2] One family borrowed 10,000 CFA from a trader and reimbursed an identical amount.

[3] The enumerators reported no incidents during the July 1977-June 1978 period.

Table XII reveals twelve cases of such pre-harvest cash borrowing.

TABLE XII

BORROWINGS BEFORE THE HARVEST

	No. of Borrowings	Mean Loan (CFA)	Mean Weight Millet (kg)	Effective Price CFA/kg
Got	1	15,000	500	30
N'Diamsil	4	1,919	64.3	29.8
Layabé	7	3,357	114.3	29.4
Sample	12	3,848	129.8	29.65

Such loans are generally of three to six months in duration, preceeding the harvest. The effective annual rate of interest (r) on these loans can be calculated as follows:

$$1. \quad P^p\,(129.8) = 3848\,(1 + r)^{\frac{N}{12}}$$

or

$$2. \quad r = \left[\frac{P^p(129.8)}{3848}\right]^{\frac{12}{N}} - 1 \quad .$$

where N = duration of loan in months,
P^p = potential price for millet.

At a potential price of 35 CFA/kg for millet, the compounded annual rate of interest is 39.4 percent for a six-month loan and 18.1 percent for a twelve-month loan. At a potential price of 32 CFA/kg, a reasonable post-harvest price in the N'Diamsil or Layabé areas, the effective annual rate is 16.5 percent for a six-month loan. While varying with the potential millet price and the duration of the loan assumed, these derived interest rates do not approach the 100-200 percent returns often cited.

F. Towards a Modeling of Millet Sales

In order to understand more fully the producer's decision to sell millet, a model was specified. Annual producer sales (kg) of millet were assumed to be a function of the weighted millet price (CFA/kg), the millet per capita annually produced by the compound, and the annual groundnut production of the compound.[1] Both price and millet per capita were assumed to be positive influences on millet sales. Groundnut production was assumed to be negative; lower groundnut production would oblige a compound to sell greater quantities of millet, to compensate for reduced income from groundnut sales. The results of this testing are shown in Table XIII.

TABLE XIII

MILLET REGRESSION MODEL

Independent Variable	Coefficient	Standard Error	Significance
Constant	-1,290.0	549.9	.03
Millet Price (CFA/kg)	29.2	12.3	.03
Millet Production/ Capita[a] (kg)	.85	.38	.04
Groundnut Production[a] (kg)	.05	.017	.001
F Statistic	4.81		.01
R-SQR	.41		
SE	242.2		

Dependent variable: Millet sales per compound (kg)

[a] Mean of 1976 and 1977 production per compound.

The influence of price on millet sales was as expected; higher prices elicited greater sales. An increase of one CFA/kg in the producer millet price would increase sales by approximately twenty-nine kilograms. The implied price elasticity of supply at the mean is 3.51. This suggests that millet sales are relatively price elastic. Such a conclusion should not be surprising; producers, if unsatisfied with the millet price, can always store millet for later consumption, or await a more favorable price.

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[1] The value of the producer's debt to his cooperative for inputs should also be included as an independent influence; however, these data were not available.

Since the official groundnut price showed no variation over the time frame of this study, nor among villages, groundnut production is a suitable proxy for groundnut income.

Millet production per capita was also positive, indicating that millet sales are a function of the millet available to the compound. Increasing per capita millet production by a kilogram indicates that an additional .85 kilograms will be sold.

Finally, the coefficient for groundnut production was positive, negating the hypothesis that lower groundnut production would induce higher millet sales. The most likely explanation for the positive coefficient is the fact that larger millet exploitations are often associated with larger groundnut exploitations. Thus, higher millet production per capita would be associated with higher groundnut production, assuming that yields per hectare are independent of farm size. This problem of multi-colinearity renders an interpretation of the empirical results more difficult.

Adding dummy variables to test for any independent influence by village did not improve the results of the estimated equations, nor were these coefficients significant.

G. Summary

The main findings from this discussion of millet marketing (Parts A-F) are summarized below.

1. The typical compound sold 323 kilograms of millet during the year. At a weighted mean price of 38.7 CFA/kg, this represented 12,565 CFA ($54.) of additional income for the compound.
2. The weighted mean millet price exceeded the simple mean millet price, indicating that disproportionately large quantities of millet were sold at higher prices. Both means, moreover, were in excess of ONCAD's official price of 35 CFA/kg.
3. Millet sales were relatively more frequent during the harvest and post-harvest months of November-April. There was no indication, however, that great quantities of millet were sold immediately after the harvest.
4. Prices showed seasonal variation, with lower prices occurring during the six months following the harvest. Speculating on intra-annual price variations, however, did not generate

inordinate annual returns.

5. Larger quantities of millet were generally sold either to rural traders (Got, Layabé) or at a rural market (N'Diamsil). Smaller quantities were most often sold to village storekeepers who act as rural assemblers.
6. Only four millet sales to ONCAD were reported. ONCAD's low price, delay in payment, and inaccurate weighing were all cited as reasons for avoiding ONCAD.
7. There were no reported incidents of compounds' borrowing money from traders during the survey period in anticipation of the millet harvest. Incidents of such borrowing in the past few years, however, confirmed the possibility of burdensome but not excessive rates of interest associated with this practice.
8. A regression model explaining millet sales confirmed the importance of price in the producer's sales decision. Also, millet production per capita was a positive influence on producer's millet sales.
9. While this study is primarily an investigation of grain disposition rather than an assessment of market performance and efficiency, the results presented here are consistent with the hypothesis of competitive millet marketing.

Section 5 - Gifts, Food Aid, and Borrowing/Lending of Grains

In this section, all other dispositions of grains not previously discussed will be addressed. With the exception of government food aid, a distribution of sorghum, only millet dispositions and transactions will be considered.

A. Gifts

Gifts of millet from the sample compounds were frequent. Table XIV indicates the mean number of gifts and their mean weights by village. For the entire sample, the mean quantity of millet annually given was 52.7 kg per compound. These gifts were typically small quantities of millet destined for rural or urban friends/relatives who were considered financially needy by the giver.

TABLE XIV

ANNUAL GIFTS OF MILLET/COMPOUND

	Mean No. of Gifts	Mean Weight/ Gift (kg)	Mean Weight Given (kg)
Got	2.4	16.8	40.2
N'Daimsil	4.2	8.9	37.4
Layabé	5.8	13.9	80.6
Sample	4.1	12.9	52.7

In Layabé there were three large gifts in excess of 100 kg accorded religious leaders. In the other villages, the lack of large gifts of millet for religious purposes does not imply an absence of religious obligation by this traditional Moslem population. Rather, it could reflect the evolution of monetized transactions in these villages. Since all compounds receive payments for the sale of groundnuts, a monetization of religious obligations should not be surprising.

B. Food Aid

In May and June of 1978, food aid in the form of sorghum was distributed by the government of Senegal to rural residents. This food aid was intended to mitigate the adverse effects of the poor 1977 harvest. Each compound received an amount of sorghum equal to ten kg per inhabitant. According to this distribution rule and the reported populations per compound, the following aid was received:

Got (per compound)	110 kilograms
N'Diamsil (per compound)	139
Layabé (per compound)	116
Sample (per compound)	122

The family's disposition of this aid bears some scrutiny. Since sorghum is viewed as an inferior cereal to millet, and since the typical compound, excluding Got, was self-sufficient in millet production, this distribution of sorghum did not directly improve the typical family's diet. Much of the sorghum was fed to animals, enriching the animals' diet and allowing the compounds to economize on millet as animal feed. Some compounds reported selling the sorghum either to millet deficient compounds or for use as animal feed. In conclusion, this modest amount of food aid had relatively little impact on the typical compound.

C. Borrowing and Lending

The nature of millet borrowing and loans does not lend itself to clear and simple empiricism. While it was possible to note each incident of an individual compound's loaning millet to another compound with the expectation of being reimbursed and also to note each individual compound's borrowing millet with the intention of reimbursing the millet, matching loans and reimbursements for individual cases proved difficult, for a variety of reasons.

First, many transactions involved compounds outside of the sample but within the same village. To protect the anonymity of the second party, actual names were not recorded. Thus, matching a previous loan with a reimbursement proved impossible. Second, some larger loans are repaid in installments or possibly with money following the harvest, complicating the matching of loans and reimbursements. Finally, some repayments are for loans accorded prior to the sampling period, just as some loans occurred just as the sampling period ended. Thus, one portion of the transaction was outside the sampling period.

Despite the inability to match borrowings and loans, sufficient evidence exists to evaluate the importance of these transactions relative to the compound's millet supply.

Tables XV and XVI show the number of compounds involved in loans and borrowings, the aggregate number of transactions, and the quantity involved.

First, during the twelve month period, twelve of the thirty compounds in the sample loaned millet. The mean loan was only about nine kilograms, sufficient for two days of compound millet consumption (assuming 1477 kg as the annual compound millet consumption; see Chapter IV, Section 2). Borrowing of millet was more frequent, with forty individual transactions involving sixteen compounds. The mean quantity per borrowing was 13.2 kilograms. All borrowings and loans involved a village neighbor as the second party. There

TABLE XV

LOANS OF MILLET (TO NEIGHBORS)

	No. of Compounds w/loans	Total No. of Loans	Total Weight (kg)	Mean Weight Per Loan (kg)
Got	2	2	42	21
N'Diamsil	6	7	48	6.9
Layabé	4	4	26	6.5
Sample	12	13	116	8.92

TABLE XVI

BORROWINGS OF MILLET (FROM NEIGHBORS)

	No. of Compounds w/Borrowings	Total No. of Borrowings	Total Weight (kg)	Mean Weight Per Borrowing (kg)
Got	3	4	92	23.0
N'Diamsil	9	27	378	14.0
Layabé	4	9	57	6.3
Sample	16	40	527	13.2

were no extra-village borrowings/lendings reported. Reported borrowings and lending were generally of small magnitudes; none exceeded 50 kg. Primarily, families borrow millet to compensate for unforeseen shortages of prepared millet. Usually, once a week millet is taken from storage to be threshed and prepared for cooking. Occasionally families underestimate their needs, and will borrow millet, repaying it after the next weekly threshing of millet.

It was not possible to match millet borrowings and repayments to calculate any effective rate of interest associated with these transactions. An independent questionnaire to the sample group, however, revealed that all thirty compounds anticipated repaying or being repaid exactly the quantity involved in the transaction. No interest on these millet loans was expected. Since the loans are generally for convenience, of short duration, and of minimal quantities, such a response should not be surprising. In summary, millet borrowings were not of major importance relative to millet production.

Section 6 - Summary of Major Transactions

The section attempts to integrate the empirical findings from the preceding sections, giving better perspective to the grain dispositions and transactions previously discussed. Ideally, an annual "grains-in, grains-out accounting statement" would simply and conveniently serve as a summary. Unfortunately, calculating grain balances is not a simple task; rather it is complicated by the following factors.

First, there is no time period within which all dispositions can fall. Inter-annual grain storage is common and at the end of any arbitrary accounting time frame, stocks would either be augmented or depleted depending on the grain-in/grain-out differential.

Second, this sample transcended two harvests, 1976 and 1977. This complication is really an extension of the timing problem discussed in point one. Assuming that nearly all of a harvest is disposed of during the year, point one becomes trivial. The complication of point two, however, would still remain.

Third, no reliable estimate of grain losses during harvest, storage or preparation has been generated. The arbitrariness of the per-compound estimate used in this study understates the importance of this issue. Despite the above problems, Table XVII attempts to summarize the principal uses of grains as found in this village level study.

With the exception of millet used for seed and for animal consumption, each of the noted items has been discussed in preceding sections. Millet seed is relatively insignificant, an estimated 1.5 kg/ha planted. Animal feed in Got and Layabé is relatively important, averaging 213 and 131 kilograms per compound, respectively. In these two communities, animals (horses and cows) are relatively numerous, reflecting their usefulness as draft traction and for transport.

The sum of millet dispositions per compound during the sample period ranged from 1345 kilograms in Got to 2884 in N'Diamsil, with a sample mean of 2236 kilograms. For the entire sample, the 2236 kg represent approximately 75 percent of 1977 millet production, or 73 percent of the mean 1976-1977 production. Got had the largest percentage of production accounted for by the listed items. In fact, with the sharp decline in millet production reported for the 1977 harvest, Got's annualized total of millet disposition would exceed the 1977 harvest.

The typical compound in N'Diamsil and Layabé undoubtedly had additional surpluses of millet. A portion of this millet is kept in on-farm storage, comprising the peasant's security stock against unforeseen events. Due to the widespread knowledge that the 1977 harvest had been worse than 1976 harvest in most parts of Senegal, many farmers with surpluses were holding millet in anticipation of significantly higher millet prices in July-October of 1978. Since these months were outside the sample period, such transactions would not have been noted. Thus, the derived millet "surpluses" for N'Diamsil and Layabé, include some addition to security storage, but could also represent producer speculation with millet.

The only transactions involving rice were consumer purchases. Rice consumption and purchases were nearly identical, since consumers have no rice supply source other than purchasing. Mean compound rice consumption was highest in Got, followed by Layabé. In these two villages, 33 percent and 16 percent, respectively, of annual grain consumption was satisfied by rice. For the entire sample, mean per capita grain consumption was 160 kg, roughly equalling the nutritional standard recommended for rural Senegal.

Chapter V will use these empirical results in assessing the Senegalese government's program for promoting food self-sufficiency.

TABLE XVII

SUMMARY OF GRAIN DISPOSITION (KG/COMPOUND/YEAR)

	Got	N'Diamsil	Layabé	Sample
MILLET				
1. 1976 Production (kg/compound)	1962	4830	2470	3126
2. 1977 Production (kg/compound)	1222	3655	4015	2964
3. Mean 1976-1977 Production (kg/compound)	1592	4243	3243	3045
4. 10 percent post-harvest loss	159	424	324	305
5. Compound Consumption	920	1893	1620	1477
6. Animal Feed	25	213	131	123
7. Sales	194	309	306	270
8. Gifts	40	37	81	53
9. Seed (1.5 kg/ha)	7	8	9	8
10. Total, (4-9)	1345	2884	2471	2236
11. 10. as % of 3	85%	68%	76%	73%
12. 10. as % of 2	110%	79%	62%	75%
RICE				
13. Consumption	448	180	309	312
14. Purchase	432	168	316	305
GRAIN CONSUMPTION				
15. Total/Compound (kg)	1368	2073	1927	1789
16. Per Capita (kg)	128	174	179	160

[a] The larger exploitations in Layabé and N'Diamsil result in a higher animal/compound ratio in these villages; thus the higher per compound millet consumption by animals.

CHAPTER V

MAJOR FINDINGS AND RECOMMENDATIONS

This chapter will review the main findings from this study of producer grain transactions, examining them within the context of official Senegalese agricultural policy. This permits an evaluation of the likelihood of achieving these stated policy objectives.

Essentially, Senegalese objectives for the agricultural sector are to attain food grain self-sufficiency and to increase rural incomes. Specifically, increased local production of grains would replace the 200,000 tons of broken rice annually imported. The reduction in rice imports would greatly aid in alleviating Senegal's perennial current account deficit, assuming no concurrent reduction in groundnut production and export.

The overall self-sufficiency strategy includes actions to affect both the supply and the demand for grains. Significant increases in local rice and maize production are envisioned, with a more modest increase in millet production. From the demand perspective, shifting the composition of grain consumption, particularly in urban areas, towards more millet and maize, with less reliance on rice is a major priority.

While the empirical results of this study do not bear directly on each of those individual actions, some comment will be directed to each point in the strategy.[1]

(1) While increasing domestic paddy production from the current 100,000 tons to 300,000 tons (1985) is technically feasible with water management, the domestic resource cost of this rice will greatly exceed the current cost of imported rice. Assuming this increased paddy production is forthcoming, the government must confront this pricing question, choosing some combination of official producer price decrease, national subsidy, and/or official consumer price increase. A sensitivity of peasant rice purchases to the consumer rice price was indicated by the empirical results of this study (Chapter IV, Section 3). In this case, an increase in the consumer rice price could reduce rural rice consumption but would

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[1] The assessment of the demand related points is primarily drawn from the author's work on urban consumption in Dakar.
See: Ross, Clark, "Grain Demand and Consumer Preferences", Dakar, Senegal, CRED, June, 1979.

increase rural millet consumption, further limiting the marketing of millet. Also, frustrating the peasants' desire for a more diversified diet, which includes increased rice consumption, could further alienate the rural population from existing government institutions.

(2) Increasing domestic maize production from the current 50,000 tons to 210,000 tons by 1985 appears to be a reasonable possibility. Maize grows quite well in the lower Sine-Saloum, as well as in the Thiès-Diourbel area, the location of the three sample villages. At the official price of 41.5 CFA/kg and with current yields per hectare and per labor unit, peasants would find the profitability of maize nearly equaling that of groundnuts and generally exceeding that of millet. In such a case, the introduction of maize in the Thiès-Diourbel area would probably be at the expense of millet cultivation. Farmers might concentrate on groundnut and maize cultivation, to the detriment of millet. In fact, farmers selling maize at the attractive official producer price would probably increase their consumption of purchased rice, due to the reduction in millet planting.[1] In this case, the objectives of food self-sufficiency and reduced rice imports would not be achieved.

Also, producer experiences with ONCAD as a purchaser of primary grains (Chapter IV, Section 4) cast doubt on ONCAD's ability to coordinate the projected increase in marketed maize.

(3) Increasing domestic millet production from 550,000 to 730,000 tons (1985) is relatively unlikely at current producer prices. The empirical results of this study have shown that producers concentrate resources into the production of groundnuts, a more profitable production possibility. To induce farmers to increase millet production at the expense of groundnuts would necessitate some change in the relative prices of the two crops. Reducing the producer groundnut price would be a politically unacceptable alternative, given Senegal's commitment to increasing rural incomes. Increasing the official producer price of millet from 35 CFA/kg to the estimated 55 CFA/kg needed to equalize the profitability of the two crops would imply a cost price for millet of 85-90 CFA/kg in Dakar after adding all intermediate expenses. At that price, it is highly unlikely that urban demand could absorb an increased millet supply.

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[1] The cost per kilogram of purchased rice expressed in terms of a locally grown cereal has been reduced due to the greater profitability of maize than that of millet.

(4) Reducing rice consumption from a projected 335,000 tons to 234,000 tons in 1985 would primarily be achieved by limiting urban rice demand, with increased millet and maize consumption. Reducing urban rice demand, without sharply increasing rice prices, will be difficult. Of equal concern, the growing attachment to rice by the rural sector could result in further increases in national rice consumption. The typical rural family sampled in this study had 19 percent of its grain needs satisfied by rice. Assuming that rice is a normal good and diet diversification a continued objective, rising rural incomes will lead to increases in rice demand. Thus, achieving a reduction in national rice consumption depends not only on the behavior of the urban population but also on that of the rural sector.

(5) Stimulating maize flour consumption in both urban and rural areas is an important objective, considering the projected maize production increases. A large portion of this planned maize consumption would be in rural areas. Attracting the rural population to greater maize consumption would be particularly benefitial if accompanied by a concurrent reduction in rural rice demand. Maize, which can be prepared in a fashion similar to broken rice, could then serve to promote a more diversified grain diet. As previously explained, the rural population is currently consuming rice to diversify its traditionally millet-based diet.

(6) Increasing millet flour consumption is primarily aimed at the urban population, whose current rice-based diet is the source of the costly dependence on rice imports. Since the typical rural household in this sample had a grain diet dominated by millet (81 percent), it is unlikely that further increases in the proportion of millet in the rural sector's diet can be achieved.

Generally, the empirical results of this study of producer grain transactions are not supportive of Senegal's objectives for the agricultural sector. On the supply side, introducing maize could lead to reductions in millet cultivation. Secondly, without some price incentive, it is unlikely that millet production can be significantly increased. On the demand side, reducing rice consumption is hindered by the rural population's desire for a more diversified diet. Increasing rural millet consumption is complicated by the same desire for a varied diet.

The main theme emerging from this study of rural producers is the necessity to consider their behavioral patterns in formulating national policy. Too often, a sterotyped model of peasant behavior has been assumed. Successfully designing agricultural policy for Senegal requires not only an understanding of urban grain demands but a thorough comprehension of producer decision making with respect to resource allocation, sales, and consumption patterns. It is hoped that this study has shown the interrelationship between such behavior and the design of national policy.

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ECONOMIC GROWTH IN THE MIDDLE EAST, 1950-72

by

Robin Barlow

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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ABSTRACT

The first part of this paper presents estimates of per capita GNP in constant U.S. dollars for each of the 23 countries of the Middle East in each of the years from 1950 to 1972. The method of estimation is based on the use of physical indicators like the number of telephones per capita, a method which is domonstrably superior to the conventional procedure of using official exchange rates to convert national currency estimates of GNP into dollar estimates. The second part reviews the main causes of the upturns and downturns in the per capita GNP growth curve for each country. This review leads to some generalizations about the causes of eocnomic growth and decline in the Middle East during the period in question.

SOMMAIRE

La première de ce document offre des estimations individuelles du PNB, en dollars constants des 23 pays du Moyen-Orient pourchacune des vingt-deux années allant de 1950 à 1972. La méthode employée est basée sur l'utilisation d'indicateurs physiques tels que le nombre de téléphones par habitant. Cette formule s'avère infiniment supérieure au procédé plus conventionnel employant les taux de change officiels pour la conversion des estimations de la monnaie nationale en estimations de dollars. La seconde partie examine les causes principales des retournements positifs et négatifs de la courbe de croissance du PNB individuel de chaque pays. Cette analyse permet d'élaborer plusieurs généralisations concernant les origines de la croissance et du décline économiques au Moyen-Orient pendant cette période.

ECONOMIC GROWTH IN THE MIDDLE EAST, 1950-72

Robin Barlow

I. INTRODUCTION

The year 1973 was clearly a turning-point in the recent economic history of the Middle East. On October 1 of that year, the price of Arabian Light, a representative type of Middle Eastern crude oil, stood at $3.01 per barrel. On October 16, following the outbreak of the Arab-Israeli war, the price rose to $5.12. By January 1, 1974, the price had reached $11.65, as OPEC further exploited its opportunities for cartel profits. In consequence, there was an international transfer of purchasing power -- from oil importers to oil exporters -- unprecedented in its scale and suddenness. The Middle East has been the major beneficiary of this transfer. Of the twenty-three countries in this region (as defined here), ten were by that time important exporters of oil, and benefited directly from the transfer. Other Middle Eastern countries benefited indirectly, as the oil states expanded their demand both for imported commodities and for immigrant labor, and stepped up their programs of financial assistance to less favored parts of the region. So 1973 saw the start of an acceleration of Middle Eastern growth that was both rapid and widely diffused.[1]

For most countries of the region, the years before 1973 can therefore be treated as a distinct phase of economic development, differing in several respects from what came later. It is the purpose of this paper to review the economic performance of the Middle Eastern economies during this earlier period. The year 1950 is chosen as a starting point. By this date, recovery from the major dislocations caused by the Second World War was largely complete, and national accounts began to be available in greater abundance. The measure of economic performance which is used here is per capita gross national product expressed in U.S. dollars of constant (1976) purchasing power. In Section II of the paper, some methodological problems involved in estimating per capita dollar GNP are discussed. In Section III, charts detailing the annual growth of per capita

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[1] Furthermore, three of the countries without large oil deposits--Morocco, Tunisia, and Jordan--were significant exporters of phosphates, and so benefited from the fourfold increase in phosphate prices which occurred between 1973 and 1974.

GNP between 1950 and 1972 in each of the countries of the region are presented. In Section IV, some comments are offered on the factors explaining the ups and downs of the growth curve in each country.

Of course, estimates of per capita GNP in constant dollars are already available for Middle Eastern countries in such publications as the United Nations' Statistical Yearbook and the World Bank's World Tables, and it may be asked what this paper has to offer beyond what already exists. Three points may be made. First, earlier estimates for the years going back to 1950 are scattered across several different publications, and there is some convenience in having everything brought together in one place. Second, an attempt is made here to provide per capita GNP estimates for all twenty-three countries of the region in each of the twenty-three years of the chosen period--a total of 529 separate estimates, many of which have no precedents in existing sources. Third, the method used here for expressing per capita GNP in U.S. dollars is demonstrably superior to the method conventionally used, which involves applying official exchange rates to GNP estimates expressed in national currencies. As a result, the relative ranking of the Middle Eastern countries according to their per capita dollar GNP is somewhat different here from that normally reported.

It is probably necessary to add a word in defense of per capita real gross national product as a measure of economic performance. In recent times, various inadequacies of this measure have been stressed. There is, for example, the environmentalist argument that growth in the GNP is normally accompanied by environmental damage and therefore exaggerates the actual increase in material well-being that has occurred. There is the egalitarian argument that an increase in per capita GNP may not entail any improvement for low-income groups if the distribution of income has become more unequal at the same time. These points have some merit, but they do not render per capita GNP useless as a measure of well-being. There seems to be a high degree of correlation between per capita gross national product (or other closely related concepts like gross domestic product or national income[2]) and "broader" indexes of well-being such as environmentalists or egalitarians might prefer[3]. In the great majority of cases, a sustained rise in per capita real GNP will be accompanied by an improvement in the average family's standard of living[4].

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[2] GNP is the market value of all final goods and services produced by factors (land, labor, and capital) owned by nationals of the country in question. GDP is the value produced by factors located within the country's boundaries. Before the recent nationalizations, GDP exceeded GNP by an appreciable margin in the Middle Eastern oil states, since a large fraction of the income generated within these states was paid as profits to the foreign owners of the oil facilities. National income measures the factor income paid to nationally owned factors of production, and therefore equals GNP minus depreciation and indirect taxes.

[3] Wilfred Beckerman, In Defence of Economic Growth (London: Jonathan Cape, 1974), p. 85.

[4] See, for example, Gary S. Fields, "Who Benefits from Economic Development? - A Reexamination of Brazilian Growth in the 1960's," American Economic Review 67 (September 1977): 570-82.

II. METHODOLOGICAL ISSUES

For a proper evaluation of the per capita GNP estimates presented in this paper, it is necessary to describe in some detail how they were derived. To obtain for several countries estimates for several years of per capita GNP expressed in constant dollars, two separate problems must be solved: in any one year, the levels of per capita dollar GNP in each country must be in the correct relation to each other (the problem of international comparisons); and within any one country, the growth of per capita real GNP over the period in question must be correctly measured (the problem of estimating national growth). These two issues will be considered in turn.

International Comparisons

As noted above, the standard method of estimating GNP in dollars involves taking a GNP estimate expressed in units of the national currency and converting that to dollars through the use of the official exchange rate. This method has been recognized as having some serious defects. First, there may be no single "official" exchange rate. In an attempt to achieve a balance-of-payments equilibrium, a government may create a system of widely ranging exchange rates, each one applying to a particular set of transactions. It is then far from obvious which rate should be used for national product conversions. For example, in Turkey the principal exchange rate applying to exports in 1957 was 2.80 liras per dollar; the principal rate for imports was 3.96 liras per dollar; and the official rate for tourists was 5.75 liras per dollar. Which of these rates should be used to convert into dollars the 1957 Turkish per capita GNP estimate of 1,208 liras?

Second, even if there is a single official rate (or a narrow band of rates), that rate may suddenly change as the result of a devaluation. Per capita dollar GNP after the devaluation looks much less impressive than before, and it is not clear which figure should be preferred. The official exchange rate for the Israeli pound in 1961, for example, was 1.8 pounds per dollar, and Israel's per capita GNP in 1961, estimated at 2,506 pounds, would at that exchange rate be equivalent to $1,322. In 1962 the national-currency estimate of per capita GNP rose to 2,885 pounds. But also in that year the exchange rate became 3 pounds per dollar. Converting the 1962 per capita GNP estimate into dollars at the new rate yields a figure of only $962, which conveys a rather different impression about the relative standing of the Israeli economy.

Third, even if there is a single exchange rate which remains roughly constant for the entire period under review, that rate will reflect the relative prices of only a limited set of commodities at best. In Lebanon, for example, the exchange rate between the dollar and the Lebanese pound has generally been determined by market forces. As a result, the exchange rate -- about three pounds per dollar in most years of our period -- has reflected the relative prices of the goods traded between the U.S., Lebanon, and third parties (automobiles, cigarettes, etc.): a quantity of cigarettes costing one dollar in the U.S. would cost about three pounds in Lebanon, after allowance for transportation costs and local taxes. But the exchange rate does not reflect the relative prices of commodities not traded internationally. In Lebanon and in low-income countries generally, such commodities, like personal services, normally cost less in relation to internationally traded commodities than they do in the United States. Three pounds will go much further in buying haircuts or taxi rides in Lebanon than will one dollar in the United States. Hence using the rate of three pounds per dollar to convert Lebanese GNP from a pound figure to a dollar figure yields a definite understatement of Lebanese output or living standards.

What makes matters worse is that the official exchange rate often does not even reflect the relative prices of traded commodities. For various reasons, authorities have often maintained artificial exchange rates which are far removed from what market forces would produce. Such rates are obviously quite inappropriate for national product comparisons.

A proper comparison of the GNP in two countries clearly involves taking account of the relative prices of both traded and nontraded commodities. This is achieved in a method of comparison known as "repricing." To estimate Lebanese GNP as a fraction of U.S. GNP, the output volumes of both countries are valued at U.S. prices. (U.S. prices are used to obtain the value of Lebanese haircuts in dollars, etc.). The GNP ratio thus calculated is clearly sensitive to the particular set of prices employed. If Lebanese rather than U.S. prices were employed in valuing the output volumes of the two countries, a different GNP ratio would be obtained. The repricing method normally involves using first one price set and then the other, and taking an average (conventionally the geometric mean) of the two GNP ratios.

By 1978 the repricing method, which involves the collection of detailed information on the prices and quantities of individual commodities, had been applied in 47 countries.[5] Only one of these, Iran, was in the Middle East.[6] But this does not mean that we are thrown back on the official exchange rate method for making estimates of Middle Eastern GNP in dollars. Two other methods of estimation exist, neither as good as the repricing method but both superior to official exchange rate conversion, and both of them have been used in the present study.

The first of these second-best methods relies on physical indicators. When data for several different countries are assembled, it has been noted that a high degree of correlation exists between (a) dollar GNP estimated by repricing and (b) various physical indicators such as cement production or the stock of radio receivers. For countries where no repricing study has been undertaken but where data on the physical indicators do exist, an estimate of GNP in dollars may therefore be obtained by assuming the same relationship between GNP and the indicators as prevails among the reference countries where repricing estimates of GNP are available.[7]

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[5] The repricing estimates for 43 of these countries are discussed in Irving B. Kravis, "A Survey of International Comparisons of Productivity," Economic Journal 86 (March 1976): 1-44. Estimates for the remaining four countries are discussed in Irving B. Kravis et al., "Real GDP Per Capita for More Than One Hundred Countries," Economic Journal 88 (June 1978): 215-42.

[6] The derivation of the Iranian estimate is reported in detail in Irving B. Kravis et al., International Comparisons of Real Product and Purchasing Power (Baltimore: Johns Hopkins University Press, 1978). Two repricing estimates of per capita Iranian GNP in 1970 are given by Kravis et al., one based on the geometric mean method described above and the other using a specially constructed set of "international prices" to value output. The two estimates are respectively $1,089 and $1,263 (in dollars of 1976 purchasing power), both of which are significantly higher than my estimate of $723, discussed below. The estimates of the Kravis group are based on output quantities reported by the Bank Markazi, several of which seem exaggerated. To cite one example, it is difficult to believe that per capita construction of office buildings in Iran was as high as 70 per cent of the American level.

A study by the present author, using data for forty-one countries with repricing estimates of GNP, led to the conclusion that per capita dollar GNP could be estimated with an expected error of only 16 per cent on the basis of three indicators: energy consumption, the number of telephones in use, and daily newspaper circulation, all per capita.[8] (By contrast, the errors in estimating dollar GNP through official exchange rate conversion averaged 25 per cent.) The relationship between per capita dollar GNP and the indicators is shown by the following equation:[9]

$$\log X_1 = 1.668 + 0.251 \log X_2 + 0.191 \log X_3 + 0.198 \log X_4 \quad (1)$$

where

X_1 is per capita GNP estimated by repricing method (US dollars of 1976 purchasing power)

X_2 is energy consumption per capita (kg of coal equivalent)
X_3 is telephones per capita (x 1,000)
X_4 is daily newspaper circulation per capita (x 1,000).

This equation was used to obtain a benchmark estimate of per capita dollar GNP in sixteen of the twenty-three Middle Eastern countries. The benchmark estimates were in general made for the year 1961, which was halfway through the period under study.

The remaining seven countries were handled differently. These were the oil states with small populations -- Bahrein, Kuwait, Libya, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Each of these states experienced extremely rapid growth in several years of the period, like the 30 per cent increase in per capita real GNP reportedly achieved by Libya in 1963. When growth is this rapid, the physical-indicator method does not seem to provide a very good estimate of GNP, since normally the indicators do not change much from year to year and an estimate based on them tends to fall below the fast rising level of actual GNP. Accordingly another second-best method of estimating per capita dollar GNP was used for these cases, different from the physical-indicator approach. This further method involves taking a GNP estimate expressed in units of the national currency, converting that to dollars with the official exchange rate, and then applying a correction factor to offset the downward bias inherent in official exchange rate conversion. Tests which the present author has performed with forty-one countries for which repricing estimates of dollar GNP are available suggest that this method is about as good as the physical indicator method in approximating the repricing figure.[10] The correction factor derived from that analysis is contained in the following equation:[11]

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[7] For the original development of this estimation technique, see Wilfred Beckerman and Robert Bacon, "International Comparisons of Income Levels: A Suggested New Measure," Economic Journal 76 (September 1966): 519-36.

[8] Robin Barlow, "A Test of Alternative Methods of Making GNP Comparisons," Economic Journal 87 (September 1977): 450-59.

[9] Among the 41 reference countries, 37 possessed data on all three indicators. Equation (1) was estimated by ordinary least squares from data for these 37 cases, and yielded an R^2 of 0.97 (i.e. the equation explained 97 per cent of the variance in log X_1).

$$\log X_1 = 0.413 + 0.901 \log X_5 \qquad (2)$$

where X_5 is per capita GNP estimated by converting a national currency estimate into dollars at the official exchange rate (in US dollars of 1976 purchasing power). Among the seven oil states in question, national currency estimates of GNP were available for Kuwait, Libya, and Saudi Arabia, and Equation (2) could therefore be used to establish benchmark estimates of per capita dollar GNP in those three cases.

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[10] Barlow, loc. cit., p. 455.

[11] Equation (2) was estimated from data for 38 of the 41 reference countries and yielded an R^2 of 0.94.

For the remaining four oil states, Bahrein, Oman, Qatar, and the United Arab Emirates, all of which are in the area of the Arabian Peninsula, no estimates of GNP in national currencies were available, and Equation (2) therefore cannot be used directly. Dollar GNP may nonetheless be estimated for these four cases if it is recognized that economic growth in all of them has been closely tied to their oil sectors, as is also true for the other Arabian oil states, Kuwait and Saudi Arabia. In all six cases, there is a common pattern of evolution, starting with a primitive, subsistence economy based largely on pastoralism and fishing, followed by the opening up of the oilfields, and the subsequent use of rising oil revenues to build up local industrial sectors (usually petrochemical in nature), social infrastructure (schools, hospitals, roads, etc.) and military forces. It can be presumed therefore that there is in these countries a close relationship between constant-dollar GNP and some readily available indicator of oil activity like government oil revenues or the volume of crude oil production. This relationship can be measured for Kuwait and Saudi Arabia, since for these two countries there is a benchmark estimate of dollar GNP, based on Equation (2), and in addition for Saudi Arabia there is a series of real GNP estimates expressed in the national currency. The basic similarity between the economies of Kuwait and Saudi Arabia on the one hand and those of Bahrein, Oman, Qatar, and the United Arab Emirates on the other then makes it legitimate to assume that the relationship between oil and dollar GNP observed in the former two countries applies also in the latter four.

Accordingly, the following equation, based on Kuwaiti and Saudi data, was used for estimating dollar GNP in Bahrein, Oman, Qatar and the Emirates:

$$X_1 = 500 + 7.66\ X_6 \qquad (3)$$

where X_6 is per capita national oil output (in barrels).[12]

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[12] National oil output is government oil revenues divided by the posted price of crude oil (Arabian Light f.o.b. Ras Tanura). This particular indicator of oil activity was chosen as being appropriate for estimating the growth of real GNP over time, since it reflects changes in output volume and in profit shares between government and concessionaire (changes which affect real GNP) but does not reflect changes in oil prices or terms of trade (changes which do not affect real GNP). One might note as an aside that a measure of real product which did reflect changes in the terms of trade (the ratio of an export price index to an import price index) would be superior to real GNP for estimating changes in welfare over time, but such measures are not generally available for Middle Eastern countries before 1960. One of the few examples is the series on "real gross national income" estimated by Mead for Egypt (Donald C. Mead, *Growth and Structural Change in the Egyptian Economy*). The intercept and slope of Equation (3) were determined from the following conditions:

a) the per capita dollar GNP of Kuwait in 1970 would be the same under both Equations (2) and (3);

b) subject to that, Equation (3) would minimize the unexplained variance in the ten estimates of per capita dollar GNP in Saudi Arabia (1963-72) which were obtained by linking the constant-price national-currency GNP series to the benchmark estimate of dollar GNP derived from Equation (2).

The resulting equation explains 84 per cent of the variance in the ten Saudi estimates, all of which were much smaller than the single Kuwaiti estimate. Data on oil revenue and prices were obtained from O.P.E.C., *Annual Statistical Bulletin*, 1973.

A Comparison of Comparisons

It is reasonable to ask how the dollar GNP estimates obtained by the above methods compare with the estimates yielded by the standard method of official exchange rate conversion. In Table 1 the countries of the Middle East are ranked by their 1970 per capita dollar GNP as estimated by the physical-indicator method and the other special methods linked to repricing. This per capita GNP figure is shown in Column 1 of the table. In Column 4 is shown per capita dollar GNP as estimated by official exchange rate conversion. The two estimates are compared -- in the form of the ratio between them -- in Column 5.

Three main points emerge from an examination of Column 5. First, for some countries no estimate of per capita dollar GNP can be made with the method of official exchange rate conversion, because no estimate of GNP in the national currency has been published. The data requirements of the repricing-linked methods are much more modest, and so all countries of the region can be covered by those methods. Second, in those countries where per capita dollar GNP can be estimated both by repricing-linked methods and by official exchange rate conversion, the estimate based on the former methods is always higher than that based on the latter. The main reason for this, as suggested above in our discussion of Lebanese exchange rates, is that the prices of nontraded commodities relative to the prices of traded commodities tend to be lower in low-income countries than in high-income countries like the United States. This phenomenon, which in turn is probably caused by the relative abundance of the relevant factors of production in the two types of economy, is recognized by the repricing approach but ignored by official exchange rate conversion.

Third, the ratio between the two GNP estimates varies widely from country to country. For some countries, like Israel and Libya, the two estimates are quite close together. For others, the repricing-linked methods produce estimates far above those yielded by official exchange rate conversion. In seven of the countries, per capita dollar GNP estimated by repricing-linked methods is

TABLE 1

ALTERNATIVE ESTIMATES OF PER CAPITA DOLLAR GNP IN MIDDLE EASTERN COUNTRIES, 1970

	Per capita GNP estimated by repricing-linked methods (current $)[1] (1)	Per capita GNP in current-price units of national currency[2] (2)	Annual average official exchange rate (units of national currency per $)[2] (3)	Per capita GNP estimated by official exchange rate conversion (current $)[3] (4)	Col. 1 as percentage of Col. 4 (5)
1. Qatar	$5,005	*	*	*	*
2. Kuwait	3,719	1,212 dinars	.3571	$3,394	110%
3. U.A.E.	3,485	*	*	*	*
4. Israel[4]	1,931	6,672 pounds	3.500	1,906	101
5. Libya	1,745	573.7 dinars	.3571	1,607	109
6. Cyprus	1,337	367.5 pounds	.4167	882	152
7. Saudi Arabia	1,197	3,572 rials	4.500	794	151
8. Lebanon	999	1,709 pounds	3.269	553	181
9. Bahrein	656	*	*	*	*
10. Oman	619	131.8 riyals	.4167	316	196
11. Turkey	588	3,982 liras	13.20	302	195
12. Jordan[5]	540	97.63 dinars	.3571	273	198
13. Iran	500	27,851 rials	75.75	368	136
14. Egypt	462	90.21 pounds	.4348	207	223
15. Iraq	457	119.8 dinars	.3571	335	136
16. Syria	450	1,042 pounds	4.310	242	186
17. Algeria	409	1,612 dinars	4.937	327	125
18. Morocco	398	1,126 dirhams	4.963	227	175
19. Tunisia	377	141.6 dinars	.5249	270	140
20. South Yemen	193	41.11 dinars[6]	.4167	99	195
21. Sudan	149	38.00 pounds	.3482	109	137
22. Afghanistan	107	4,511 afghanis	81.90	55	195
23. North Yemen	87	418.9 rials[6]	5.500	76	114

1. Source: Appendix below, with estimates expressed in dollars of 1970 purchasing power.
2. Sources: for North Yemen and South Yemen, U.N., Yearbook of National Accounts Statistics; for other countries, World Bank, World Tables, 1976.
3. Col. 2 ÷ Col. 3.
4. Excluding occupied territories.
5. Including West Bank.
6. Per capita gross domestic product.

roughly twice as high as the levels conventionally reported.[13] This means that in many instances, the relative standings of two given countries are much altered if a different method of estimating dollar GNP is used. To cite one comparison which is often made in military and journalistic analyses, Egyptian GNP in 1970 appears to be only about 24 per cent larger than Israeli GNP when the method of official exchange rate conversion is used.[14] But repricing-linked methods suggest that the Egyptian GNP was nearly three times as large as the Israeli. As indicated above, the repricing-linked methods are not always accurate, but their average error is significantly less than what official exchange rate conversion is subject to.

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[13] Discrepancies of this magnitude or even larger have been found for some countries outside the Middle East where full-blown repricing studies have been conducted. The ratio between the level of per capita dollar GNP determined by such studies and the level resulting from official exchange rate conversion is 250 per cent for Colombia and 335 per cent for India. See Kravis et al., International Comparisons, p. 10.

[14] See, for example, Time (January 10, 1977), p. 50: "The foreign money entering Israel spurred growth that has given Israel a G.N.P. only a shade smaller than that of Egype, though its population, at 3.3 million, is less than a tenth the size."

Estimating National Growth

Benchmark estimates of per capita dollar GNP having been obtained, it remained to estimate the annual rate of growth in each country's per capita real GNP both before and after the benchmark year. For Bahrein, Kuwait, Oman, Qatar, and the United Arab Emirates, this was an easy task: Equation (3), relating GNP to oil output, was used to estimate per capita dollar GNP in all years of the period.[15]

For the other eighteen countries of the region, estimates of the annual rate of growth in real GNP were in general taken from published sources. These sources were usually official in nature, such as governmental yearbooks or reports to the United Nations, but in some cases estimates by private authors were used instead. (References are given in the appendix to this paper). For ten countries, the published sources provided real GNP estimates for all twenty-three years of the period under study: Afghanistan, Algeria, Cyprus, Egypt, Iran, Israel, Morocco, Syria, Tunisia, and Turkey.

For the eight remaining countries, there were gaps in the published sources, and these were filled by techniques of estimation based on a variety of indicators. In four of the countries, two of the physical indicators appearing in Equation (1) -- energy consumption and telephones -- were used to fill in gaps of varying length.[16] For Iraq, estimates for three years out of the twenty-three year period were made in this way, and similarly for Jordan (nine), Lebanon (fourteen) and

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[15] Except for the pre-oil years in Oman and the Emirates, when other estimation methods described in the appendix below were used.

[16] Equation (1) itself could not be used in these cases, since for the years and countries in question there were no data on newspaper circulation. When there was information on both energy consumption and telephones, the following equation was used:

$$\log X_1 = 1.807 + 0.290 \log X_2 + 0.294 \log X_3 \qquad (4)$$

When nothing more than telephone data was available, the following was used:

$$\log X_1 = 2.544 + 0.552 \log X_3 \qquad (5)$$

Equations (4) and (5) were each estimated from data for 37 of the 41 reference countries mentioned above. R^2 was 0.96 in (4) and 0.92 in (5).

Sudan (four).

In the cases of Libya and Saudi Arabia, the gaps in the real GNP series were not filled by using indicators from Equation (1), because as noted above the indicators in question do not give good estimates of dollar GNP when growth is very rapid. The gaps for Libya, occurring in ten years of the pre-oil period, were filled from Equation (2).[17] For Saudi Arabia, estimates for the thirteen missing years were derived from Equation (3).

In South Yemen, the bulk of output beyond the subsistence level was generated by the British military presence, entrepôt trade and the servicing of shipping in Aden, and the oil refinery. Available indicators of these activities are crude oil imports and vessel tonnage entering Aden, and these have been used for estimating GNP.

For North Yemen, finally, there is an acute shortage of helpful statistics. The benchmark estimate for 1970, based on energy consumption, telephones, and newspapers, has been assumed to apply to the whole of the period under study. Accounts of the North Yemen economy suggest that there may have been some ups and downs during this period, but no pronounced trend away from its historic state of low-level stagnation.

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[17] In general, Equation (2) is not suitable for estimating the rate of growth in real GNP, since the current-price national-currency estimates of GNP used in the equation reflect terms-of-trade changes, which are irrelevant for measuring changes in real GNP. However it does not seem likely that the results for Libya during the pre-oil years in question are seriously biased.

III. BASIC RESULTS

The estimates of per capita dollar GNP obtained by the above methods for the individual countries of the Middle East are shown on a semi-logarithmic scale in Figure 1.[18] For the purpose of graphical presentation, the countries are divided into five groups. The per capita GNP estimates appearing in Figure 1 are also enumerated in the appendix below, along with the population estimates employed, and more details on the methods and sources used. It goes without saying that the estimates are of widely varying reliability. Many should be regarded as highly tentative, but are probably adequate as establishing rough orders of magnitude.

The last part of Figure 1 shows the growth in per capita dollar GNP for all Middle Eastern countries combined.[19] For purposes of comparison the growth in the United States' per capita GNP during the same period is also included. It is obvious that growth was faster among those Middle Eastern countries which were important exporters of oil than among the remainder, and so growth curves for these two groups of countries are also shown. The per capita real GNP of the oil states grew half again as fast as that of the non-oil states between 1950 and 1972. It is nonetheless of interest that even the non-oil states, considered as a group, grew faster than the United States during this period.

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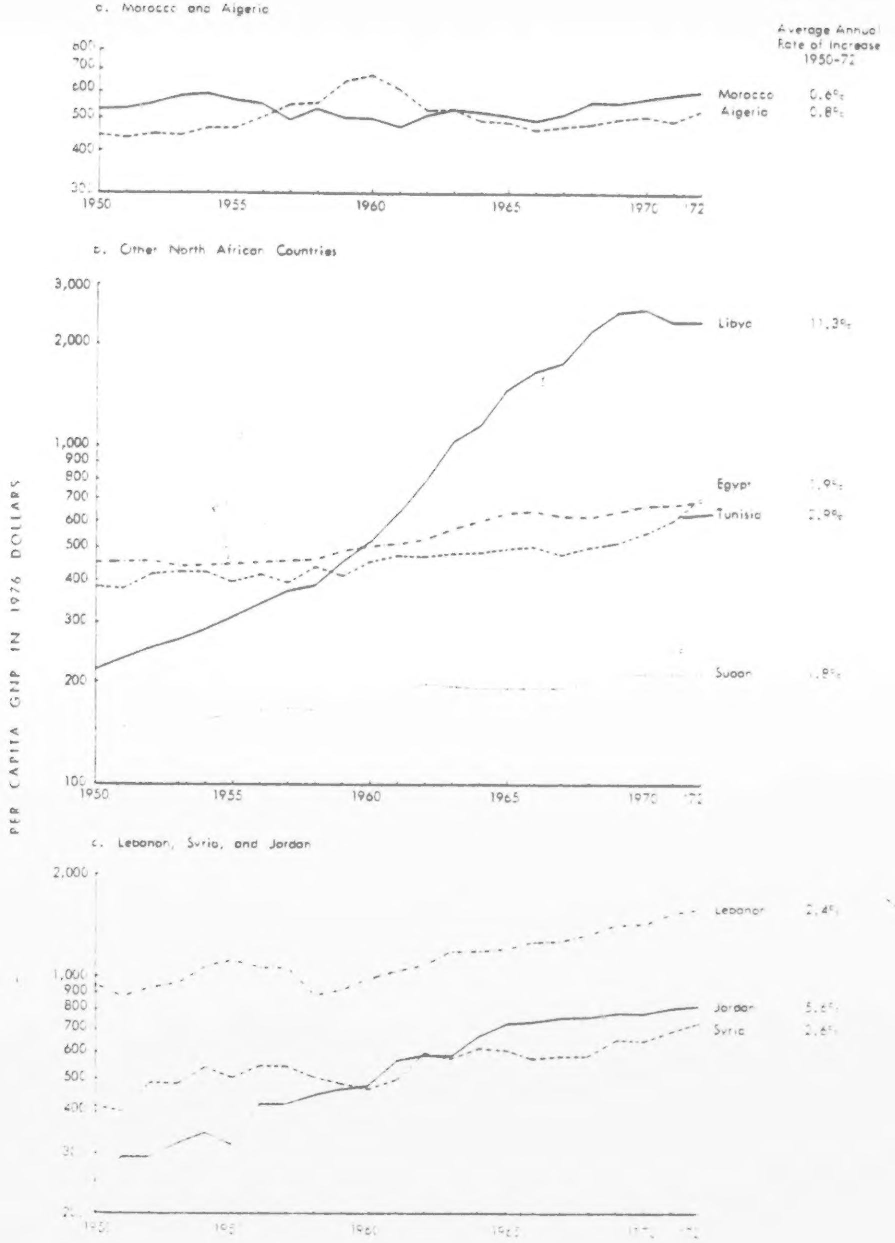
[18] With a semi-logarithmic scale, a steepening (flattening) of the growth curve from one year to the next indicates an increase (decrease) in the percentage rate of growth.

[19] For the purpose of these regional estimates of per capita GNP, the Middle East is defined as the twenty-three countries whose growth curves are shown in Figure 1, plus Gaza. As indicated in the appendix below, per capita GNP in Gaza in 1966 (expressed in Jordanian dinars) was estimated to be 23.2 percent of per capita GNP in Jordan. In making the regional per capita GNP estimates, the same ratio between per capita GNP in Gaza and in Jordan is assumed to prevail in all other years of the period between 1950 and 1972.

Figure 1

PER CAPITA DOLLAR GNP IN THE MIDDLE EAST

1950-1972



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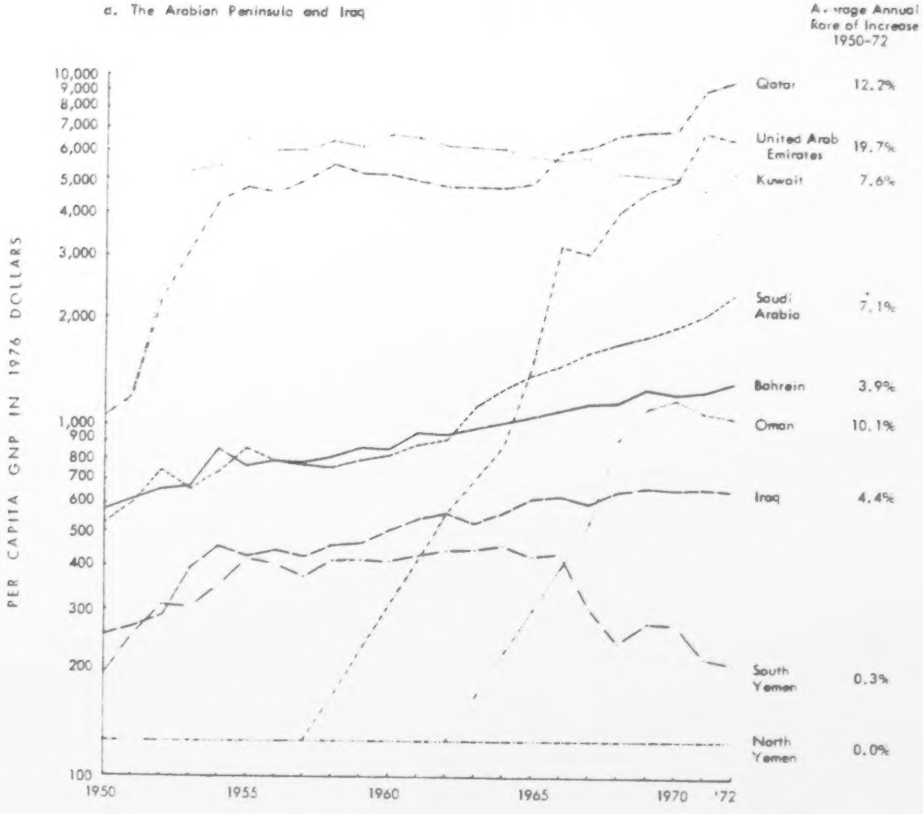
a. The Arabian Peninsula and Iraq



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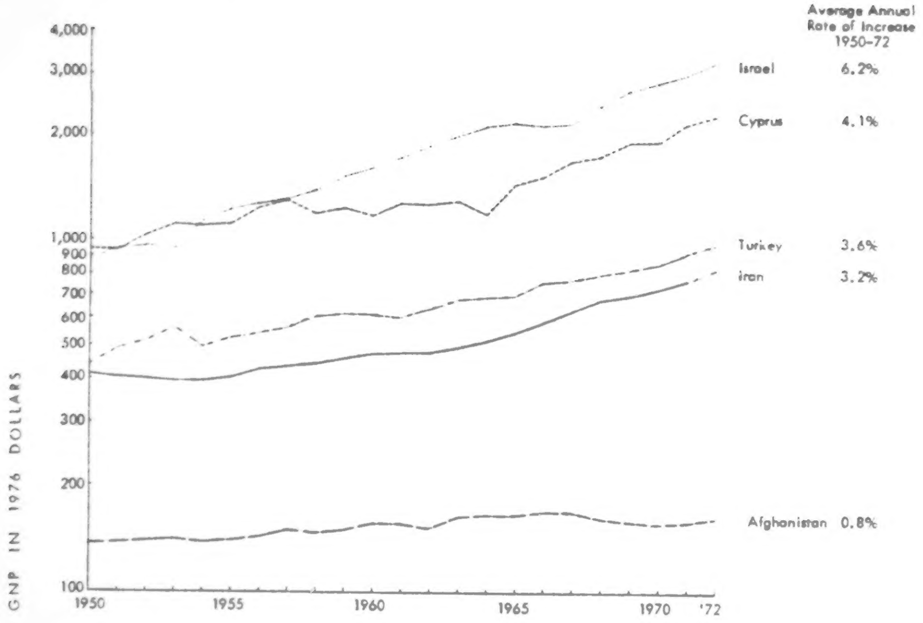
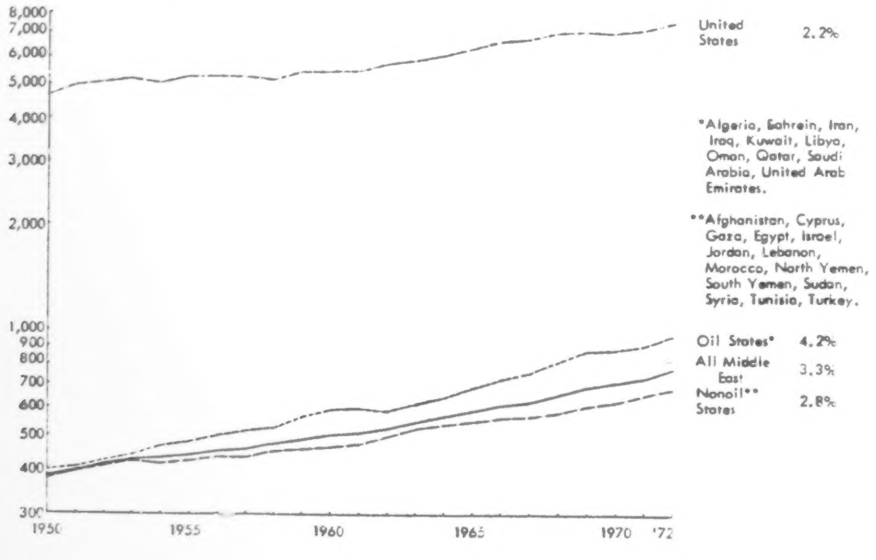
e. Non-Arab States



f. The Middle East and the United States



*Algeria, Bahrein, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, United Arab Emirates.

**Afghanistan, Cyprus, Gaza, Egypt, Israel, Jordan, Lebanon, Morocco, North Yemen, South Yemen, Sudan, Syria, Tunisia, Turkey.

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IV. SOME FACTORS EXPLAINING ECONOMIC GROWTH

We offer finally some explanations for the accelerations and decelerations of economic growth which are apparent in Figure 1. The objective here is not to give an exhaustive explanation of each country's growth experience, but only to touch on a few of the more salient features. Taking the countries in the order in which they appear in Figure 1, we note first that the growth curves for Morocco and Algeria have some important similarities, reflecting their common experience of decolonization. Initially, during the last years of colonial rule, there was in both countries an appreciable rise in per capita product. In part this was due to an increase in military expenditures, as the French authorities attempted to suppress the national independence movements, and this fact should serve to remind us that an increase in per capita GNP does not necessarily imply an improvement in average living standards.

The attainment of independence, occurring in 1956 in Morocco and in 1962 in Algeria, was followed by a significant decline in per capita GNP. Both economies had become thoroughly permeated by French resources -- of capital, management and even labor -- and the exodus of the settlers following independence caused widespread disruptions. In agriculture, for example, French-owned landholdings which had been farmed as large-scale, mechanized units were in many cases subdivided among peasant cultivators, and output suffered as a result, at least for a time. In Morocco the problems caused by the exodus were compounded by droughts in 1957 and 1961. But the economic decline was more severe in Algeria, per capita GNP falling 31 per cent from its peak in 1960 to its post-independence trough in 1966. This drastic decline reflected the greater role which the French community had played in Algeria (in comparison with the Moroccan situation), and was also attributable in part to the failures of many of the socialist experiments which the new Algerian governments introduced. (It is also true in both countries that the decline in per capita income for the indigenous inhabitants was less than that for the population as a whole, since the income of the departing settlers had been relatively high.)

Eventually, towards the end of our period, both countries experienced a resumption of growth. In Morocco the agricultural sector expanded significantly, in part due to the completion of large-scale irrigation schemes, and tourism also flourished. In Algeria, the oil sector seems to have been the major pôle de croissance. The recovery in both countries, however, was retarded by the high rates of population growth prevailing. The Moroccan and Algerian birth rates remained at high levels, as was true in most Middle Eastern countries, and this created serious burdens of economic dependency.

Decolonization also shaped the course of economic growth in Tunisia. The attainment of independence in 1956 was followed by the exodus of most of the French and Italian settlers, who had played key roles in the Tunisian economy as administrators, businessmen, and technicians. Their departure caused many dislocations, and output suffered. At the same time, the political uncertainties following independence had a negative effect on investment: the capital stock grew at a slower rate, and the stagnation of output was prolonged. These problems were aggravated by periodic bad harvests, to which Tunisia with its uncertain rainfall is particularly prone. Significant declines in output occurred for this reason in 1955, 1957, and 1959, as well as later in 1967.

The negative effects of decolonization on output were somewhat cushioned by the programs of Destourian Socialism introduced after 1960. There was a rapid expansion of the public sector, and many of the workers left unemployed by the European exodus were absorbed into government service. At the same time, substantial foreign aid from the United States helped to restore the rate of fixed investment, which averaged over 20 per cent of gross national product between 1960 and 1967. This doubtless was part of the reason for the acceleration of growth which started in 1968. Agriculture emerged from a long stagnation, by some accounts because of the policies of décollectivisation adopted. Tourism also made a major contribution to the Tunisian takeoff, and a further impetus was provided by the exploitation of the offshore oilfields.

The oil boom arrived earlier and on a much larger scale in Libya, with the result that by 1972 per capita GNP in Libya was higher than in any other country of Africa. Oil revenues in significant amounts were first received by the Libyan government in 1962. Thereafter growth was very rapid, as the oil companies were quick to exploit Libya's geographical advantage in relation to the European markets. This advantage over the Persian Gulf producers became even more pronounced after the closing of the Suez Canal in 1967, and in 1968 the volume of Libyan crude oil production was 73 per cent higher than the 1966 level. Oil production reached a peak in 1970, after which the new Qaddafi regime forced the oil companies to curtail their output, as part of its campaign aimed at higher prices and higher taxation.

Rapid growth had occurred in Libya during the 1950's, before the era of large-scale oil production. The economy started that decade in a very primitive condition, not unlike that of the Arabian Peninsula states in their pre-oil stage. An expansion then occurred in the American and British military bases, generating increases in local income. Further increases occurred as the oil companies started exploration in the late 1950's.

In _Egypt_, three phases of growth may be discerned in the period under study. First, the early years of the Nasser regime, established by _coup d'état_ in 1952, saw a general stagnation. Agricultural output failed to expand, partly because the land reforms immediately instituted by the new regime inevitably led to some temporary dislocations. Several public services were curtailed, as the government adhered for a time to the principles of "sound finance," attempting to avoid the large deficits which had characterized the last years of the Farouk era. The Suez Canal was closed for several months after the Anglo-French-Israeli invasion of 1956, and further losses of output resulted.

In 1958 the economy entered a phase of positive growth which lasted until 1965. It was the public sector, under the banner of "Arab Socialism", that was responsible for the expansion. New industrial enterprises were established under public management. A military buildup took place and social welfare programs expanded. The reopened Suez Canal handled an ever-increasing volume of oil traffic from the Persian Gulf. During this phase, foreign aid was received on a large scale from both the United States and the Soviet Union, with favorable effects on the rate of economic growth.

But during the last part of our period, the activist foreign policy pursued by the Nasser régime led to some serious economic problems. Egypt's intervention in the Yemen civil war proved to be very costly. The swift rise in military expenditures precipitated a foreign exchange crisis, and the resulting curtailment of imports caused many production cutbacks in the civilian sector. Even more catastrophic for the Egyptian economy was the 1967 war with Israel. The Canal was again closed, the tourist business collapsed, the Suez oil refinery was destroyed, and the Sinai oil wells fell into Israeli hands. The losses of output which all this involved were compounded as morale sank and inefficiencies multiplied in the public sector, which by this time encompassed the great bulk of economic activity. Thus Egypt's experience between 1950 and 1972 provides several illustrations of how political miscalculations can retard economic development.

The economy of the Sudan also made relatively little progress during this period. There are severe geographical obstacles to Sudanese growth. The population centers are widely distant from each other and from the Red Sea ports, with the result that production for internal markets and for export faces unusually high costs of transportation. No gratuitous developments took place to alleviate these problems, developments of the kind that benefited many Middle Eastern countries during the period in question. No oil was discovered, and no massive financial aid was forthcoming from either the U.S. or the U.S.S.R., neither of whom regarded the Sudan as being in a politically critical zone. To make matters worse, a bitter civil war raged between North and South in most years of the period, with deleterious economic consequences.

In the case of Lebanon too, no oil was discovered and no large-scale aid was received. (And after the end of our period there was a bitter civil war which caused economic ruin). Nevertheless, the Lebanese economy grew at a considerable rate, apart from some setbacks in the late 1950's. The Suez crisis of 1956 and the civil unrest of 1958 caused temporary declines in output from several sectors -- tourism, for example. But subsequently, between 1958 and 1972, per capita real GNP grew at an average annual rate of 4.3 per cent. The relatively high level and the relatively rapid growth of Lebanese income was mainly attributable to the success of various sectors providing services to the outside world: international banking, currency exchange, entrepôt trade, airline traffic, the narcotics business, and tourism. These activities flourished in the laissez-faire atmosphere of Lebanon, where the government applied only minimal levels of regulation and taxation.

The Lebanese economy is highly vulnerable to outside forces, but between 1950 and 1972 the positive forces generally outweighed the negative. The Arab-Israeli wars of 1956 and 1967, for example, both caused losses of tourist business for Lebanon, but the closing of the Suez Canal also occurring in both instances was of indirect benefit to Beirut, which was able to serve as an alternative port for countries of the hinterland, particularly Jordan and Iraq. The creation of an autarkic police state in neighboring Syria, along with the Syrian drought of 1958-61, caused losses for Lebanon in income from tourism and trade. But these same political developments also led to an exodus of businessmen and private capital from Damascus, and Beirut was one of the beneficiaries. Capitalistic Beirut also benefited from similar flights of capital and personnel away from socialist regimes in Egypt and Iraq. Above all, the oil boom in the Persian Gulf region brought prosperity to Lebanon in a variety of ways. Income was derived from the passage of Iraqi and Saudi oil through pipelines terminating at Lebanese ports. The oil towns of the Gulf provided a growing market for Lebanese fruits and vegetables. The Gulf sheikhs invested heavily in Beiruti real estate and became major clients of the Lebanese banking and tourist industries.

The flight of capital and capitalists from Syria is undoubtedly a major explanation for the lengthy stagnation apparent in that economy during the middle part of the period under review. Between 1957, when leftist forces started to gain control, and 1968, per capita real GNP grew at an average annual rate of only 0.8 per cent. Before 1957, there had been a substantial investment of private capital in large-scale farming ventures in the eastern part of the country, and agricultural output rose impressively. Even in that period, however, there were setbacks due to bad weather, such as in 1955, and the serious drought of

1958-61 added to the problems which had to be faced during the early stages of Syrian socialism.

Another reason for the prolonged stagnation in Syria was that the socialist governments, having taken over from the private sector the task of capital formation, spent relatively little on capital projects with a quick payoff. Much was spent on the armed forces and on long-payoff infrastructure projects, like the Euphrates Dam and the railroads linking the port of Latakia to the interior. By the late 1960's some of these projects were starting to produce results, and the growth rate of the GNP improved. A further stimulus was provided by the exploitation of the north-eastern oilfields.

Throughout the whole period, it should be added, Syrian development was seriously retarded by high fertility. The successive governments followed strong pronatalist policies, and in many years the crude birth rate in Syria, hovering around 47 per thousand, was the highest in the entire Middle East.

Jordan achieved a rapid growth rate during the period under study, second only to Israel among the non-oil states of the Middle East. In fact between 1950 and 1967 -- in the latter year Jordan lost so much of its territory and resources to Israeli control that its economy became radically altered -- the Jordanian growth rate exceeded the Israeli. The Jordanian expansion during those years was fairly well diversified. Irrigation projects like the East Ghor canal increased agricultural output; phosphate mining became well established; many manufacturing plants were created; there was a boom in tourism based on the religious sites in Jerusalem, Bethelehem and elsewhere. The explanations for the rapid growth are not hard to find. There was an immense capital inflow, in some years exceeding one-fifth of the national product, the main sources being the governments of the United States, Britain, and Kuwait, as well as the United Nations. And the Palestinian communities living in Jordan provided an abundant source of merchants, managers, and skilled workers.

After the Arab-Israeli war of 1967, the West Bank passed under Israeli control, and Jordan thereby lost about 40 percent of both its population and output. Israeli authorities permitted some commerce to continue between West and East Banks, but as time went on the West Bank became more closely tied to the Israeli economy and less closely tied to what was left of Jordan. Available statistics do not permit good estimates of the real growth occurring in West and East Banks separately after 1967.[20] It seems clear, though, that the strife between Palestinian guerrillas and Jordanian authorities in 1970 caused a definite interruption in economic growth on the East Bank.

The next group of countries to be considered are those in the Arabian Peninsula along with Iraq (Figure 1.d). Of the nine countries involved, all except two (North Yemen and South Yemen) had become important exporters of oil by the end of the period under study, and their economic growth during this period was largely conditioned by the rate of extraction of their oil deposits. The largest of the seven oil states in terms of population -- and the one with the most extensively developed non-oil sector -- was Iraq. At the start of the period, Iraq experienced spectacular growth, per capita real GNP rising by 180 per cent between 1950 and 1954. The oil sector was largely responsible for this leap forward: the Iraqi government secured more favorable profit-sharing arrangements with the oil companies, and the production of Iraqi crude expanded greatly to fill much of the gap left by the temporary closure of the Iranian oilfields. But the high rates of increase in Iraqi oil revenues were not sustained. For the remaining years of the Hashemite monarchy, overthrown in 1958, there was little economic growth. Agriculture stagnated, in part because of an oppressive land tenure system. The government's development projects had little short-run payoff, consisting predominantly of large-scale dams and roads. The Suez crisis lowered oil revenues, as the Canal was closed and pipelines sabotaged.

Growth resumed during the first years of the socialist phase in Iraq, which began with the Kassem regime in 1958 and continued with a succession of Baathist governments after 1963. Again, the oil sector provided the main impetus, the volume of crude oil output rising by 90 per cent between 1958 and 1966. After 1966, however, real per capita GNP stagnated. Oil output failed to increase appreciably. In 1967 the flow of oil was interrupted by the Arab-Israeli war, and in other years of the period, an ongoing struggle between the radical regimes in Baghdad and the Western-owned Iraq Petroleum Company had the effect of depressing output. Outside the oil sector, private lands and businesses continued to be expropriated, and were then reorganized under the auspices of an overextended bureaucracy. This process also seemed to cause losses of output, at least in the short run. And the long armed struggle against the Kurdish minority involved additional heavy costs.

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[20] The growth rates of Jordanian per capita real GNP shown for 1967-72 in Figure 1 are estimated from physical indicators (per capita energy consumption and telephones) which apply to West and East Banks combined.

Four states of the Arabian Peninsula -- Bahrein, Kuwait, Qatar and Saudi Arabia -- were important exporters of crude oil during the entire period from 1950 to 1972. Virtually all of their economic growth during these years is attributable directly or indirectly to their oil sectors, and their growth curves shown in Figure 1.d are mostly derived from Equation (3), which estimates real per capita GNP solely on the basis of oil activity.[21] The factors explaining the pattern of growth in real per capita GNP in these four states can be summarized as follows:

a) There was a very large increase in the volume of oil output in all cases, the volume more than doubling in Bahrein between 1950 and 1972, increasing about tenfold in Kuwait and Saudi Arabia, and about fifteenfold in Qatar. The increases in percentage terms were particularly rapid during the Iranian nationalization crisis of 1951-54, when the Arab producers took over much of Iran's share of the world export market. The increases were below normal in the aftermath of the Arab-Israeli wars of 1956 and 1967.

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[21] It should be noted that the level of real per capita GNP in Saudi Arabia, quite apart from its rate of increase, is highly uncertain. This is because there is much disagreement about the size of the population. The Saudi government claims a 1972 population in excess of six million, but some observers think that the real figure is only about half as large as that. In this paper one of the smaller estimates of the Saudi population has been used.

b) A further reason for the rapid increases in real GNP during the early 'fifties was the rising share in oil profits obtained by all four governments, following the "50:50" agreement negotiated between Saudi Arabia and Aramco in 1950. This formula then remained largely unchanged for the next twenty years. In 1971 and 1972, the governments secured markedly higher fractions of the oil profits, as the terms of the Libyan agreement of 1970 were extended to other countries of the region.[22]

c) In Kuwait and Qatar, the population grew rapidly because of immigration. Between 1950 and 1972, the annual rate of population growth averaged about 10 per cent in Kuwait, and about 6 per cent in Qatar. As a result, per capita GNP declined in some periods even though GNP itself was increasing quite substantially.

The other two Arabian oil states, Oman and the United Arab Emirates, started oil production in the 'sixties. Real per capita GNP rose meteorically in these cases, as within a very few years the main economic activity changed from primitive pastoralism to large-scale oil extraction.

By contrast, the remaining states of the Arabian Peninsula, South Yemen and North Yemen, ended the period with very low levels of real per capita GNP. The economy of South Yemen has consisted essentially of two parts: modern activities in the port of Aden (shipping services, oil refining, and until 1967, a British military base) and traditional activities in the hinterland (subsistence agriculture and pastoralism). The economy has experienced some major changes in real per capita GNP since 1950, and these have mostly been due to various developments in the modern sector. In the general absence of national accounts, the real per capita GNP series shown in Figure 1.d is based on two indicators -- crude oil imports and vessel tonnage entering Aden. The series is therfore only a rough approximation of the truth, but probably captures fairly well the main expansions and contractions of the economy. The period from 1950 to 1955 saw a definite expansion, as the volume of tanker traffic to and from the Persian Gulf increased, much of it stopping at Aden. Also, the oil refinery started operations in 1954. There was then a phase of stagnation, lasting from 1956 to 1966. The closing of the Suez Canal in 1956 and 1957 caused some income losses for Aden in those years, and increasingly frequent strikes by trade unions in the port caused further interruptions. In 1957 a major economic decline started. The Suez Canal was once again closed, this time for a much longer period, and international shipping was re-routed away from the Red Sea and Aden. The British military forces withdrew, and those Adenis who had provided them with goods and services became unemployed. The colonial authorities were replaced by régimes that were Marxist and xenophobic, and the members of the European, Indian, and Pakistani business communities quickly departed, causing further losses.

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[22] Also in these years the posted price of crude oil started to rise significantly, after more than twenty years of stability. But as noted above, this development, involving changes in the terms of trade, has no effect on real GNP as conventionally defined.

As noted earlier, there are no quantitative indicators available for estimating the growth of real per capita GNP in North Yemen since 1950. The only published series covering the whole period is one on coffee production. For what it is worth, this series indicates stagnation, but the coffee sector is only a small part of the Yemeni economy. Stagnation nonetheless appears to be a fairly accurate description of the economy as a whole. Some new technology was introduced into Yemen during the 1960's, largely from Egyptian, Soviet, and Chinese sources, but the economic gains from that process were probably offset by the prolonged civil war waged during those same years.[23]

The last group of countries, those shown in Figure 1.e, are the five non-Arab states of the Middle East. Among these, real per capita GNP grew fastest and reached its highest level in Israel. Two factors account for most of Israel's economic success: the existence of a highly trained and highly motivated labor force, much of it of European origin, and an immense inflow of capital. This inflow came from a variety of sources -- economic and military aid from the U.S. government, donations and loans from the worldwide Jewish community, and governmental reparations and individual restitution payments from West Germany -- and in some years exceeded one-fifth of the Israeli GNP. The combination of skilled immigrants and large external subsidies worked almost as well in Israel as it did in Jordan, to judge by per capita GNP growth rates.

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[23] One development which was to add significantly to Yemeni incomes started near the end of our period -- the large-scale emigration of Yemeni workers to the oilfields of the Arabian Peninsula. The remittances which emigrants send back to their families are not conventionally counted as part of their native country's GNP, though these payments are counted as part of that country's "national disposable income."

The Israeli expansion was interrupted by two recessions, occurring in 1952-53 and 1966-67. Both of these were basically caused by contractionary policies instituted by government. The Israeli economy has suffered from chronic inflation and accompanying balance-of-payments problems, and on these two occasions the government attempted to remedy the situation by raising taxes, reducing budgetary expenditures, and tightening import restrictions. Unemployment resulted, reaching in 1967 a level of 12 per cent of the labor force, until the June war of that year triggered an increase in military expenditures and a resumption of economic growth.

The economy of Cyprus expanded markedly between 1950 and 1972, despite serious political disturbances. Three phases of growth can be distinguished. Between 1950 and 1957 there was a rapid expansion. World copper prices rose, stimulating additional output from the island's mines. There was also a buildup of British military forces during these years, creating many employment opportunities. Then between 1958 and 1964 the economy stalled. Political factors were mostly responsible -- the disruptive campaign of terrorism waged against the colonial authorities, and the strife between the Greek and Turkish communities which intensified after independence, culminating in open warfare in 1964. The recovery from these troubles, however, was quite rapid, and the years between 1965 and 1972 witnessed a steady expansion of the economy. Tourism and export-oriented agriculture were the leading sectors. After the end of our period, these promising developments were of course abruptly arrested by an even more serious recurrence of the intercommunal strife.

Turkey possessed the largest economy in the Middle East during the period under review. In 1972 it accounted for 17 per cent of the region's population, and for 21 per cent of its GNP. This is also the Middle Eastern country with the longest experience in the deliberate promotion of economic development, the Turkish development effort having been sustained by a series of governments starting with that of Ataturk in the 1920's and 1930's. The effort produced definite results during the period analyzed here. Real per capita GNP more than doubled between 1950 and 1972.

The expansion was particularly rapid in the first years of this period. Between 1950 and 1953, real per capita GNP rose by no less than 28 per cent. An increase in the cultivated area was a major factor, new lands being farmed with tractors obtained through an American aid program. But there were limits to the supply of unused arable land, and this kind of agricultural growth could not be long sustained. In some of the following years, particularly 1954, there were also severe droughts, with the result that the period between 1954 and 1961 saw little forward movement. The uneven performance of the Turkish economy at this time has been attributed by some observers to fiscal and monetary mismanagement by the Menderes government. Certainly the balance of payments was in frequent disarray, and the corrective measures applied from time to time, like import controls, had contractionary effects on the economy.

After 1961 the economic expansion was resumed. Several factors contributed. There was a large inflow of capital from Western countries, partly governmental and partly private, and higher rates of investment were therefore attained. The growing inflow of remittances sent by Turkish emigrants working in Western Europe eased the balance of payments situation. Outlets for exports of Turkish fruits and vegetables were developed in the countries of the Common Market, to which Turkey was admitted as an associate member. The tourist sector expanded. Thus Turkish growth during these years involved increasingly intimate ties with Europe.

The economy of Iran went from bust to boom during the period under review. The nationalization of the Anglo-Iranian oilfields in 1951 led to a stoppage of oil production and a general recession which lasted for over three years. There was a recovery after 1954, as oil production resumed under the auspices of the Consortium. The expansion was sustained by the construction of public development projects, and by a private investment boom which the government's liberal credit policies stimulated. A foreign exchange crisis then intervened, and the remedies adopted -- budgetary cuts and import restrictions -- caused a general contraction between 1961 and 1963.

For the remainder of the period and a few years beyond, Iran experienced a rate of growth which, had it occurred in Western Europe, would have been labeled an economic miracle. Between 1963 and 1972 real per capita GNP rose at an average annual rate of 6.5 per cent. Whether this surge was due more to luck or more to policy is a matter of some controversy. The Shah's regime naturally attributed the success to policy, pointing to the reforms like land redistribution carried out in the name of the White Revolution, and pointing to the internal stability which stimulated private investment , from both domestic and foreign sources. Others have noted the importance of luck in the Iranian takeoff, particularly the opportunities created by the Arab-Israeli war of 1967. Oil supplies from several Arab producers were interrupted, and Iran was able to increase its share of the oil export market. The government's oil revenues rose by 64 per cent between 1966 and 1968. At the same time the weather turned favorable, producing an unusual string of good harvests.

In Afghanistan, real per capita GNP remained at a depressed level. Some economic change did occur during the period, mostly resulting from American and Russian aid programs, but fundamentally the economy remained isolated, segmented, and technologically primitive. Towards the end of the period there was a definite decline due to a series of droughts.

Concluding Thoughts

From this review of Middle Eastern experience between 1950 and 1972, what general causes of economic growth and decline can be identified? The following causes seem important:

1. Oil

   The contribution of the oil industry to Middle Eastern growth has been obvious, both in the producing states and in those benefiting indirectly from production (like Lebanon). It is worth noting, however, that the discovery of oil, its rate of extraction, and its pricing were all largely outside the control of the Middle Eastern governments themselves during the period under review.

2. Politics

Political events profoundly affected economic growth, usually in a negative way. Several different kinds of events were important:

   i) War. The Arab-Israeli war of 1967 illustrates a variety of economic repercussions. Losers tend to suffer economic damage (Egypt), winners may profit economically (Israel). Third parties not directly involved in the conflict may enjoy large windfall gains (Iran) or suffer large windfall losses (South Yemen).

   ii) Civil war. Development was often seriously interrupted by civil war (Cyprus, Lebanon, Sudan, Iraq, North Yemen).

   iii) Decolonization. The dispossession and expulsion of colonial minorities caused economic disorder, at least in the short run (Morocco, Algeria. Tunisia, South Yemen).

   iv) Expropriation. Similarly, the expropriation of native capitalists by radical governments created difficulties (Egypt, Syria, Iraq).

3. Weather

Middle Eastern agriculture generally takes place in arid or semi-arid conditions, and economic growth was often interrupted by drought.

4. Foreign aid

Large-scale programs of foreign aid, from both East and West, led to high growth rates in some countries (Jordan, Israel, Tunisia), and prevented serious declines in others (Egypt).

5. Population growth

In Kuwait and Qatar, high rates of population growth due to immigration caused declines in per capita GNP, though those situations could hardly be described as Malthusian. In most of the rest of the region, high rates of population growth due to high fertility probably slowed the growth of per capita GNP.

> In a few cases (Cyprus, Tunisia), emigration or fertility declines held back population growth, with favorable economic results.

It is perhaps a sobering thought for economic planners that these factors were in general not susceptible to much control through economic planning.

APPENDIX

POPULATION AND PER CAPITA GNP
IN MIDDLE EASTERN COUNTRIES, 1950-72

Population at midyear in millions [a]
Per capita GNP for calendar years in constant (1976) U.S. dollars

	AFGHANISTAN		ALGERIA		BAHREIN	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	11.76	135 b	8.75	447 d	0.11	577 f
1951	11.96	137 b	8.93	439 d	0.11	615 f
1952	12.16	139 b	9.13	450 d	0.12	657 f
1953	12.37	141 b	9.37	447 d	0.12	672 f
1954	12.58	138 b	9.44	470 d	0.12	858 f
1955	12.79	140 b	9.71	470 d	0.13	765 f
1956	13.01	143 b	9.96	505 d	0.13	793 f
1957	13.23	149 b	10.14	551 d	0.13	783 f
1958	13.46	147 b	10.39	558 d	0.14	819 f
1959	13.70	149 b	10.57	649 d	0.14	865 f
1960	13.94	156 b	10.80	677 d	0.15	860 f
1961	14.18	156 b	11.02	617 c	0.15	964 f
1962	14.43	151 b	10.92	533 d	0.16	947 f
1963	14.68	162 b	11.20	539 d	0.17	983 f
1964	14.94	165 b	11.68	497 d	0.17	1,016 f
1965	15.20	165 b	11.92	490 d	0.18	1,055 f
1966	15.55	168 b	12.66	467 d	0.19	1,102 f
1967	15.90	168 b	13.08	477 e	0.19	1,151 f
1968	16.33	162 b	13.50	488 e	0.20	1,169 f
1969	16.70	158 b	13.91	505 e	0.20	1,266 f
1970	17.09	155 c	14.33	519 e	0.21	1,237 f
1971	17.48	157 b	14.77	496 e	0.22	1,259 f
1972	17.88	161 b	15.27	536 e	0.22	1,328 f

	CYPRUS		EGYPT		GAZA	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	0.50	949 d	20.53	456 i	0.29	...
1951	0.50	942 d	21.01	458 i	0.30	...
1952	0.51	1,030 d	21.52	459 i	0.31	...
1953	0.52	1,108 d	22.02	443 i	0.31	...
1954	0.52	1,100 d	22.54	446 i	0.32	...
1955	0.53	1,108 d	23.07	450 i	0.32	...
1956	0.54	1,238 d	23.61	453 i	0.33	...
1957	0.55	1,305 d	24.17	460 i	0.34	...
1958	0.56	1,193 d	24.75	476 i	0.35	...
1959	0.57	1,229 d	25.33	493 i	0.36	...
1960	0.57	1,172 d	25.92	510 i	0.38	...
1961	0.58	1,267 c	26.58	518 c	0.37	...
1962	0.58	1,257 g	27.26	538 i	0.38	...
1963	0.59	1,290 g	27.95	573 j	0.39	...
1964	0.59	1,188 g	28.66	608 j	0.41	...
1965	0.59	1,444 h	29.39	635 j	0.43	...
1966	0.60	1,504 h	30.14	643 j	0.44	171 k
1967	0.61	1,676 g	30.91	627 j	0.46	...
1968	0.62	1,741 h	31.69	622 j	0.47	...
1969	0.63	1,900 h	32.50	645 j	0.48	...
1970	0.63	1,939 h	33.33	668 j	0.50	...
1971	0.64	2,158 h	34.08	679 j	0.51	...
1972	0.65	2,273 h	34.8[illegible]	697 j	0.53	...

	IRAN		IRAQ		ISRAEL	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	16.74	411 l	5.02	254 d	1.26	872 n
1951	17.14	406 l	5.16	269 d	1.52	947 n
1952	17.55	401 l	5.30	289 d	1.61	960 n
1953	17.97	395 l	5.45	396 d	1.65	948 n
1954	18.41	396 l	5.60	457 d	1.69	1,129 n
1955	18.85	402 l	5.76	427 d	1.75	1,223 n
1956	19.30	427 l	5.92	445 d	1.83	1,270 n
1957	19.90	433 l	6.10	427 d	1.94	1,307 n
1958	20.40	445 l	6.31	460 d	2.00	1,388 n
1959	21.00	459 l	6.51	465 d	2.06	1,524 n
1960	21.52	473 l	6.73	506 g	2.11	1,609 n
1961	22.13	477 c	6.95	546 c	2.19	1,714 c
1962	22.77	476 l	7.19	558 g	2.29	1,851 n
1963	23.43	491 l	7.44	530 g	2.38	1,988 n
1964	24.08	515 l	7.71	569 g	2.48	2,105 n
1965	24.81	543 l	7.98	621 g	2.56	2,178 n
1966	25.54	583 l	8.24	636 g	2.63	2,142 h
1967	26.30	629 l	8.50	608 g	2.67	2,158 h
1968	27.08	678 l	8.78	656 g	2.74	2,447 g
1969	27.89	691 l	9.06	670 g	2.82	2,693 h
1970	28.66	723 l	9.36	660 m	2.91	2,817 h
1971	29.78	765 h	9.66	664 m	3.01	2,992 h
1972	30.55	830 h	9.98	657 m	3.08	3,260 h

	JORDAN		KUWAIT		LEBANON	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	1.31	247 o	0.11	1,058 f	1.73	949 p
1951	1.33	292 o	0.12	1,201 f	1.78	875 o
1952	1.34	292 m	0.13	2,480 f	1.82	928 m
1953	1.37	321 m	0.14	5,284 f	1.87	956 d
1954	1.41	345 d	0.16	5,465 f	1.92	1,068 d
1955	1.45	318 d	0.17	6,528 f	1.97	1,125 d
1956	1.50	421 d	0.19	6,065 f	2.03	1,066 d
1957	1.54	421 d	0.21	6,086 f	2.08	1,058 d
1958	1.60	446 d	0.22	6,494 f	2.13	887 g
1959	1.65	465 d	0.25	6,206 f	2.19	916 r
1960	1.71	477 d	0.28	6,738 f	2.25	987 d
1961	1.72	563 c	0.32	6,604 f	2.31	1,043 c
1962	1.76	587 d	0.35	6,287 f	2.37	1,076 m
1963	1.81	582 d	0.34	6,217 f	2.44	1,184 m
1964	1.87	667 d	0.43	6,156 f	2.50	1,196 m
1965	1.93	726 d	0.48	5,858 f	2.57	1,203 m
1966	1.98	735 d	0.52	5,717 f	2.63	1,269 m
1967	2.06	759 d	0.57	5,833 f	2.71	1,275 m
1968	2.12	764 m	0.63	5,240 f	2.79	1,343 m
1969	2.20	787 m	0.69	5,180 f	2.87	1,428 m
1970	2.28	780 m	0.75	5,155 f	2.97	1,444 m
1971	2.35	805 m	0.79	4,704 f	3.05	1,546 m
1972	2.44	820 m	0.84	5,332 f	3.14	1,589 m

	LIBYA		MOROCCO		NORTH YEMEN	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	0.94	219 s	8.95	533 d	3.88	126 w
1951	0.97	235 t	9.11	536 d	3.94	126 w
1952	1.01	252 t	9.34	556 d	4.01	126 w
1953	1.05	269 t	9.57	584 d	4.07	126 w
1954	1.09	288 s	9.84	596 d	4.14	126 w
1955	1.13	314 t	10.11	570 d	4.21	126 w
1956	1.17	343 t	10.40	555 d	4.28	126 w
1957	1.21	373 s	10.67	499 d	4.36	126 w
1958	1.26	389 s	10.99	537 d	4.44	126 w
1959	1.30	458 s	11.35	503 d	4.53	126 w
1960	1.35	523 e	11.64	501 d	4.62	126 w
1961	1.40	633 e	11.94	472 c	4.71	126 w
1962	1.45	805 d	12.24	514 d	4.81	126 w
1963	1.50	1,048 e	12.56	532 d	4.91	126 w
1964	1.56	1,162 e	12.88	524 d	5.02	126 w
1965	1.62	1,483 e	13.21	519 d	5.13	126 w
1966	1.68	1,667 e	13.55	496 v	5.25	126 w
1967	1.74	1,764 e	13.89	519 v	5.37	126 w
1968	1.80	2,188 e	14.25	565 v	5.50	126 w
1969	1.87	2,492 e	14.61	561 v	5.63	126 w
1970	1.94	2,524 e	14.99	575 v	5.77	126 c
1971	2.01	2,327 e	15.38	594 v	5.91	126 w
1972	2.08	2,328 e	15.85	604 v	6.06	126 w

	OMAN		QATAR		SAUDI ARABIA	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	0.50	126 w	0.02	768 f	2.52	524 y
1951	0.50	126 w	0.02	1,266 f	2.57	602
1952	0.50	126 w	0.02	2,286 f	2.63	745 y
1953	0.51	126 w	0.03	3,165 f	2.68	659 y
1954	0.51	126 w	0.03	4,354 f	2.73	737 y
1955	0.52	126 w	0.03	4,735 f	2.79	862 y
1956	0.52	126 w	0.03	4,591 f	2.84	792 y
1957	0.52	126 w	0.04	4,973 f	2.90	777 y
1958	0.53	126 w	0.04	5,531 f	2.96	761 y
1959	0.53	126 w	0.04	5,214 f	3.02	799 y
1960	0.53	126 w	0.05	5,174 f	3.08	827 y
1961	0.54	126 w	0.05	4,947 f	3.14	884 y
1962	0.54	126 x	0.06	4,793 f	3.20	913 y
1963	0.55	168 x	0.06	4,788 f	3.26	1,111 u
1964	0.55	223 x	0.06	4,735 f	3.33	1,272 z
1965	0.57	298 x	0.07	4,888 f	3.40	1,387 z
1966	0.58	396 x	0.07	6,002 f	3.47	1,482 z
1967	0.60	528 f	0.07	6,237 f	3.54	1,608 z
1968	0.62	919 f	0.08	6,747 f	3.62	1,711 z
1969	0.64	1,111 f	0.08	6,900 f	3.71	1,796 g
1970	0.66	1,189 f	0.08	6,999 f	3.80	1,906 g
1971	0.68	1,093 f	0.08	9,119 f	3.90	2,066 g
1972	0.70	1,052 f	0.08	9,688 f	4.00	2,360 g

	SOUTH YEMEN		SUDAN		SYRIA	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	0.89	197 A	8.98	145 d	3.41	416 B
1951	0.91	255 A	9.24	148 d	3.51	400 B
1952	0.93	310 A	9.50	150 d	3.61	489 B
1953	0.95	305 A	9.78	153 d	3.72	482 C
1954	0.97	352 A	10.05	157 d	3.82	541 C
1955	0.99	420 A	10.33	160 d	3.93	507 C
1956	1.01	406 A	10.64	167 d	4.05	548 C
1957	1.03	373 A	10.96	169 d	4.17	542 C
1958	1.06	416 A	11.27	167 d	4.32	506 C
1959	1.08	418 A	11.59	176 d	4.42	485 C
1960	1.10	411 A	11.90	181 d	4.58	469 C
1961	1.12	430 A	12.25	191 c	4.67	500 C
1962	1.15	445 A	12.61	199 d	4.82	599 C
1963	1.18	448 A	12.98	196 d	5.02	575 C
1964	1.20	460 A	13.33	194 d	5.12	616 h
1965	1.24	429 c	13.73	193 d	5.30	609 h
1966	1.28	438 A	14.12	194 d	5.48	572 h
1967	1.32	309 A	14.50	194 g	5.66	583 h
1968	1.36	244 A	14.94	202 g	5.85	588 h
1969	1.40	277 A	15.31	215 m	6.05	657 h
1970	1.44	274 A	15.70	215 m	6.26	650 h
1971	1.47	220 A	16.09	215 m	6.46	694 h
1972	1.51	211 A	16.49	214 m	6.67	738 h

	TUNISIA		TURKEY		UNITED ARAB EMIRATES	
	Population	Per capita GNP	Population	Per capita GNP	Population	Per capita GNP
1950	3.45	381 d	20.62	440 D	0.10	126 w
1951	3.51	378 d	21.44	490 D	0.10	126 w
1952	3.58	417 d	22.02	516 D	0.11	126 w
1953	3.64	425 d	22.62	562 D	0.11	126 w
1954	3.71	426 d	23.23	497 D	0.11	126 w
1955	3.78	397 d	23.85	522 D	0.11	126 w
1956	3.83	418 d	24.55	540 E	0.11	126 w
1957	3.89	395 d	25.27	559 E	0.11	126 x
1958	3.94	440 d	26.02	604 E	0.12	170 x
1959	4.03	413 d	26.78	614 E	0.12	230 x
1960	4.12	453 d	27.51	612 F	0.12	311 x
1961	4.21	475 c	28.24	600 c	0.12	420 x
1962	4.31	473 d	28.93	633 F	0.13	567 f
1963	4.41	482 d	29.66	675 F	0.13	708 f
1964	4.51	489 h	30.39	684 h	0.14	879 f
1965	4.61	490 h	31.15	690 h	0.15	1,470 f
1966	4.72	495 h	31.93	755 h	0.16	3,216 f
1967	4.82	480 h	32.72	766 h	0.17	3,075 f
1968	4.92	507 h	33.54	797 h	0.18	4,040 f
1969	5.03	520 h	34.38	820 h	0.20	4,622 f
1970	5.13	552 h	35.23	850 h	0.23	4,987 f
1971	5.23	603 h	36.11	918 h	0.26	6,933 f
1972	5.33	710 h	37.01	964 h	0.30	6,590 f

a. General sources for population estimates are U.N., *Demographic Yearbook* and *Monthly Bulletin of Statistics* and O.E.C.D., *National Accounts of Less Developed Countries, 1950-66*. Other estimates derived as follows:

- i) for Gaza (1968-72), annual rate of population growth assumed to be 3 per cent;
- ii) for Morocco (1961-70), annual rate of population growth assumed to be constant between census years of 1960 and 1971;
- iii) for North Yemen (1950-64), where the rate of population growth in 1966 was reportedly 2.3 per cent (U.N., *Demographic Yearbook*, 1973), growth rates for 1950 and 1965 assumed to be 1.5 per cent and 2.2 per cent respectively, with growth rates in intervening years interpolated linearly;
- iv) for Saudi Arabia (1950-72), Edmond Y. Asfour, *Saudi Arabia: Long-Term Projections of Supply of and Demand for Agricultural Products*, pp. 17, 148.
- v) for United Arab Emirates (1950-72), estimates for 1968 and 1972 from Kevin G. Fenelon, *The United Arab Emirates: An Economic and Social Survey*, and rates of population growth assumed to be 1.5 per cent in 1950 and 1960, 2 per cent in 1961, 9 per cent in 1968, and 15 per cent in 1972, with growth rates in intervening years interpolated linearly.

b. Annual rate of increase in real GNP from Maxwell J. Fry, *The Afghan Economy*.

c. Benchmark estimate derived from Equation (1). Data on energy consumption, telephones, and newspaper circulation obtained from UN, *Statistical Yearbook*.

d. Annual rate of increase in real GNP from O.E.C.D., *National Accounts of Less Developed Countries*, 1950-66 and 1959-68.

e. Annual rate of increase in real GNP from U.N., Economic Commission for Africa, *Survey of Economic Conditions in Africa*.

f. Estimated by Equation (3).

g. Annual rate of increase in real GNP from UN, *Monthly Bulletin of Statistics*.

h. Annual rate of increase in real GNP from UN, *Yearbook of National Accounts Statistics*.

i. Annual rate of increase in real GNP from Donald Mead, *Growth and Structural Change in the Egyptian Economy*.

j. Annual rate of increase in real GNP from Robert Mabro and Samir Radwan, *The Industrialization of Egypt, 1939-73: Policy and Performance*.

k. GNP estimate in Jordanian dinars cited by Brian Van Arkadie, *Benefits and Burdens: A Report on the West Bank and Gaza Strip Economies Since 1967* implies a per capita GNP equal to 23.25 per cent of the Jordanian level.

l. Annual rate of increase in real GNP from Julian Bharier, *Economic Development in Iran, 1900-70*.

m. Annual rate of increase from Equation (4).

n. Annual rate of increase in real GNP from Nadav Halevi and Ruth Klinov-Malul, *Economic Development of Israel*.

o. Annual rate of increase from Equation (5).

p. Ratio between real GNP in 1950 and in 1953 from Albert Y. Badre, "Economic Development of Lebanon," in Charles A. Cooper and Sidney S. Alexander (eds.), *Economic Development and Population Growth in the Middle East*. The 1951 and 1952 data cited by Badre are not used here, since he argues that they are based on a deflator which has misleading values in those years.

q. Ratio between real GNP in 1958 and in 1960 from O.E.C.D., *National Accounts of Less Developed Countries*, 1950-66.

r. Estimated by interpolation based on rates of increase in 1958-59 and 1959-60 derived from Equation (4).

s. Ratios between 1950, 1954, and 1957 and annual rates of increase 1958-60 from Equation (2). Data on current-price GNP from U.S. Department of Commerce, "Basic Data on the Economy of Libya" (Overseas Business Report No. 64-112).

t. Estimated by interpolation, assuming constant annual rate of increase.

u. Benchmark estimate derived from Equation (2). Data on official exchange rates from U.N., *Statistical Yearbook*, on Libyan current-price GNP from U.N., *Yearbook of National Accounts Statistics*, and on Saudi current-price GNP from Saudi Arabian Monetary Agency, *Annual Report*.

v. Annual rate of increase in real GNP from *Annuaire Statistique du Maroc*.

w. Estimated by extrapolation.

x. During an assumed period of four years of oil exploration and development preceding the first receipt of government oil revenues, per capita real GNP is assumed to increase at a constant annual rate, starting at $126 (the level estimated for North Yemen in 1970).

y. Annual rate of increase from Equation (3).

z. Annual rate of increase in real GNP from Saudi Arabian Monetary Agency, *Annual Report*.

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A. Real GNP estimated from the following equation:

$$\text{GNP in 1976 dollars} = (126)(\text{Population}) + (21.6)(\text{Crude oil imports in metric tons}) + (8.6)(\text{Vessel tonnage entering Aden})$$

The first term on the right-hand side is intended to represent the subsistence component of GNP, the coefficient on population being equal to the per capita GNP of North Yemen (in 1976 dollars) as estimated for 1970. The relative weights of the three components of GNP (subsistence, oil refining and related activities, port services and related activities) are derived from 1965 data on the composition of total output shown in Peter Mansfield (ed.), The Middle East: A Political and Economic Survey (4th edition), and the value of 1965 GNP in 1976 dollars is obtained from Equation (1). Data on oil imports from U.N., Yearbook of International Trade Statistics; data on vessel tonnage from U.N., Statistical Yearbook.

B. Annual rate of increase in real GNP from Samir Makdisi, "Some Aspects of Syrian Economic Growth," Middle East Economic Papers, 1961.

C. Annual rate of increase in real GNP from Syrian Arab Republic, Statistical Abstract.

D. Annual rate of increase in real GNP from Frederic C. Shorter, "Military Expenditures and the Allocation of Resources," in Frederic C. Shorter (ed.), Four Studies on the Economic Development of Turkey.

E. Annual rate of increase in real GNP from Z.Y. Hershlag, Turkey: The Challenge of Growth.

F. Ratio between real GNP in 1960 and in 1963 from U.N., Yearbook of National Accounts Statistics; relative annual rates of increase between 1960 and 1963 from Z.Y. Hershlag, Turkey: The Challenge of Growth.

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PROSPECTS FOR THE DEVELOPMENT OF CATTLE PRODUCTION ON MIXED FARMS IN THE PASTORAL ZONE OF NIGER: A SUMMARY

by

Edward D. Eddy, III

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

* * * *

*A summary of the principal points investigated in a monograph entitled: "The Economics of Cattle and Meat Marketing in Ivory Coast - A Summary." The full monograph and this summary are part of the Entente Livestock Study of the Center for Research on Economic Development, The University of Michigan, financed by the United States Agency for International Development (Contract AID/afr-C-1169).

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ABSTRACT

The paper is based on the results of a survey conducted by the author in 1976/77 among forty-five households in the Azawak region of Niger. The sample covered three populations: Haussa farmers and traders, Tuareg traders and wage laborers, and semi-nomadic Tuareg. Focusing on the latter group, a linear programming model of grain and livestock production is formulated. The analysis suggests that with the constraints imposed by consumption requirements and labor availability, semi-nomadic Tuareg are currently producing at optimal or near-optimal levels, as determined by value-maximizing behavior. Sensitivity analyses indicate that marginal changes in technologies and prices will have only a minor impact on the desirability of cattle production and are unlikely to reduce the area planted to grain. Structural reforms in grain markets and property law are required to induce a shift into cattle production by any of the populations covered by the survey.

SOMMAIRE

Ce rapport est fondé sur les résultats d'une étude dirigée par l'auteur en 1976/77 couvrant quarante-cinq familles dans la région Azawak du Niger. Trois populations distinctes ont été comprises dans l'échantillon: des paysans et commerçants Haussa, des commerçants et travailleurs ruraux salariés Touareg, et des Touareg semi-nomades. Ce dernier groupe a fait l'objet d'un modèle à programmation linéaire portant sur la production céréalière et animale.

On déduit des résultats de cette analyse qu'étant données les contraintes imposées par les besoins d'autoconsommation et la disponibilité de main d'oeuvre, les Touareg semi-nomades opèrent actuellement à des niveaux optima ou quasi-optima de production, jugés sur la base d'une fonction économique visant à maximiser la valeur du produit. Les analyses de sensibilité du modèle indiquent que des changements marginaux sur la technologie et les prix n'auront qu'un impact trés réduit sur la profitabilité de la production de bétail, et qu'ils n'entraineront vraisemblablement pas une diminution de la superficie consacrée à la culture céréalière. On n'observera donc un mouvement en faveur de la production de gros bétail parmi les populations étudiées qu'à la suite de réformes structurelles des marchés céréaliers et de la propriété foncière.

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Research Objectives

This paper draws on the results of a survey conducted by the author in and around a small market town on the southern edge of the Sahara Desert in western Niger. The survey ran from June 1976 to June 1977 and involved intensive interviewing among forty-five Haussa and Tuareg mixed farm households.[1]

From a national viewpoint, the area covered by the survey appears to be better adapted to livestock production than the production of grain. In particular, extensive grain cultivation in such an arid area can eliminate the permanent vegetative cover. This expedites the process of desertification.

For these and other reasons to be explained below, many development planners believe that residents of the pastoral zone, which would include the survey area and similar areas, should be forced or encouraged to specialize in cattle production. Nonetheless, grain production persists along the southern edge of the pastoral zone, and the cattle herds of mixed farmers are quite small. It appears that most residents of the southern pastoral zone prefer to combine millet and sorghum crops with goat production rather than cattle.

To investigate some of the factors behind the current production patterns, a linear programming model of a representative Tuareg mixed farming system is developed. The model is then applied to simulate the effects of three major policy options intended to promote the expansion of livestock production at the expense of grain crops. The policy options in question are: 1) grants of cattle to mixed farmers (herd reconstitution programs); 2) decreases in the price of grain, with the nominal value of livestock output remaining constant; and 3) technological innovations which would increase milk yields. The results of the analysis suggest that, given 1976 prices and the set of assumptions underlying the model, none of the above interventions are likely to induce even the best endowed Tuareg mixed farms to abandon grain production and devote all available resources to the production of cattle.

---

[1] In this context, "mixed farm" refers to producers of both grain and livestock.

This implies that development planners must reconsider strategies currently proposed for the pastoral zone. As an alternative to such strategies, several policy recommendations are put forward. Such schemes might relieve the major labor constraints restricting crop and livestock production, as well as provide a means of protecting the southern pastoral zone from further desertification.

The first section of the paper introduces the reader to the environment within which the research was conducted and to which the results of the analysis might be applied. It is followed by a brief description of the methodology employed for the survey and the ensuing analysis. The third section describes and compares the three production systems covered by the survey (Bush Tuareg, Village Tuareg, and Haussa). The use of inputs (labor, land, and livestock) and the magnitude and patterns of disposal of agricultural output are discussed in this section. The fourth section contains a description of the average seasonal labor requirements of Bush Tuareg agricultural enterprises, broken down by the major activities associated with each enterprise. The fifth section contains the analysis of Bush Tuareg agricultural production, this system having been chosen as the most representative of the majority of residents of the southern pastoral zone. The final sections of the paper present the conclusions which may be drawn from the analysis and a discussion of the policy recommendations mentioned above. For a more exhaustive treatment of the topic, the reader is referred to the research monograph on which this paper is based.[1]

---

[1] Eddy, Edward D., Labor and Land Use on Mixed Farms in the Pastoral Zone of Niger, Center for Research on Economic Development, University of Michigan, and USAID, 1979.

Introduction to the Research Site

Location of the Research Site: The Pastoral Zone and The Azawak Region.

-- The location of the pastoral zone in Niger is indicated by the dotted area in Figure 1. The pastoral zone is defined as the area where cattle production is possible in all seasons of the year (SEDES, 1973). This corresponds to the area proposed for the specialized livestock production zone, as described above. It also roughly corresponds to an eco-climatic zone variously defined as the northern Sahel or sub-desert. Average annual rainfall within this zone varies from 150 mm in the north to 350 mm in the south.

The pastoral zone forms a fragile buffer between the more densely populated grain-producing areas to the south and the practically uninhabited desert to the north. There is enough rain in the area to support grasses, but rarely enough, even on the southern fringe, to support rainfed agriculture. With little interference from grain fields in most areas and adequate water supplies for livestock throughout the year, the open rangeland of the pastoral zone appears well suited for extensive livestock production.

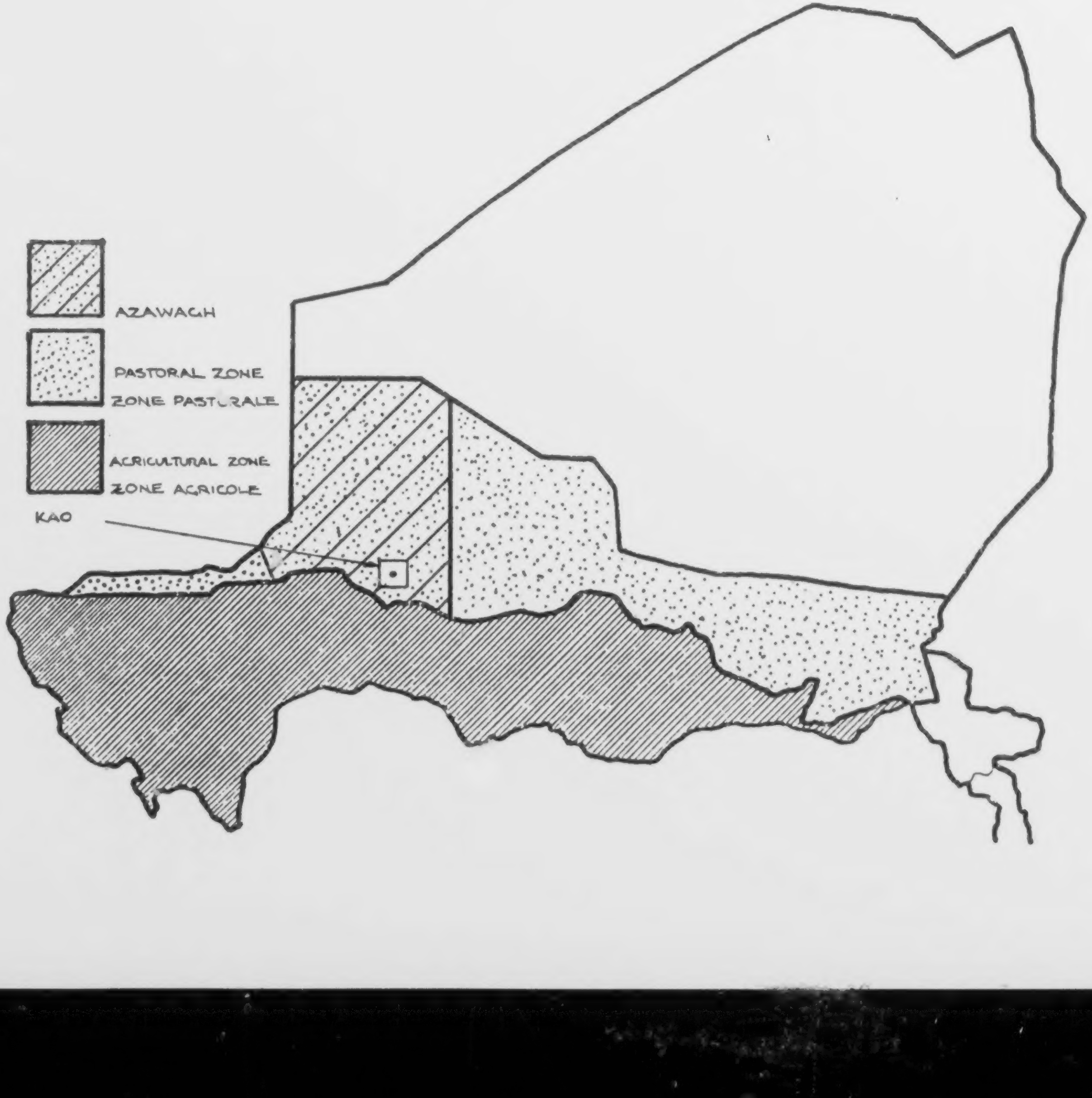
Most of the western portion of the pastoral zone lies within a region known traditionally as the Azawak (see Figure 1). The research site is located in the southern portion of this region and along the southern edge of the pastoral zone. The populations covered by the survey inhabited a 900 square kilometer area, indicated in Figure 1, centered about the market town of Kao in the political subdivision known as the Tchin-Tabaraden *Arrondissement* (Tahoua Department).

Climate.

-- Areas in the southern pastoral zone have one rainy season during the year, which usually runs from June to September. The rainy season is followed by a hot/wet season, which lasts until the dry winds blowing off the desert descend to the lower atmospheres in November. The desert winds mark the advent of the cold season, which lasts from November to March and is characterized by perpetual dust storms. As the area is desiccated by the desert winds, temperatures rise, reaching their annual maxima during the hot/dry season which lasts from March until the early rains in June.

FIGURE 1

AGRICULTURAL PRODUCTION ZONES IN NIGER


AZAWAGH
PASTORAL ZONE
ZONE PASTORALE
AGRICULTURAL ZONE
ZONE AGRICOLE
KAO

Average maximum and minimum temperatures during these seasons are indicated in Figure 2. The cold season at the beginning of the year is the time when the daily temperature differential is the greatest. During this season, air temperature may drop by as much as 17° C between late afternoon and nightfall.

The area along the southern edge of the pastoral zone, to which the results of the following analysis may be expected to apply, lies between the 300 and 350 mm isohyets of average annual rainfall, as indicated in Figure 3. As suggested above, the 350 mm isohyet roughly marks the southern boundary of the pastoral zone. Kao, the center of the survey area, received an average of 323 mm of rainfall annually during the period for which the isohyets in Figure 3 have been calculated.

However, average annual rainfall is an illusory statistic. The intertemporal and interspatial distribution of rainfall in such northern areas of West Africa is marked by extensive variability. Figure 4 indicates the extent of such variability over the seventeen-year period preceding the survey, during which annual rainfall at Kao ranged from 185 to 475 mm.

Figure 4 also suggests the importance of deviations from the mean level of precipitation. Mean annual rainfall for the first half of the period was well above the overall mean, whereas the mean for the second half was well below. The second half of the period was the time of the well-publicized Sahelian drought. Although the recent drought was not without precedent, it was unusual in that it was exacerbated by historical factors, to be described below.

Deviations from trend are as important for monthly or even daily variations in rainfall as for annual variations. The timing of the rains are as important as the amount, since the timing determines the composition of grasses on the range and may determine whether or not a crop yields anything at all. Heavy early rains, for instance, will favor rapidly maturing grasses, whereas deficit rainfall towards the end of the rainy season may eliminate some varieties from the range by preventing late-maturing grasses from bearing seed. The timing of the rains also influences labor patterns, as will be illustrated below.

FIGURE 2:

MEAN MONTHLY MINIMUM AND MAXIMUM TEMPERATURE:
TAHOUA, NIGER, 1960-1976

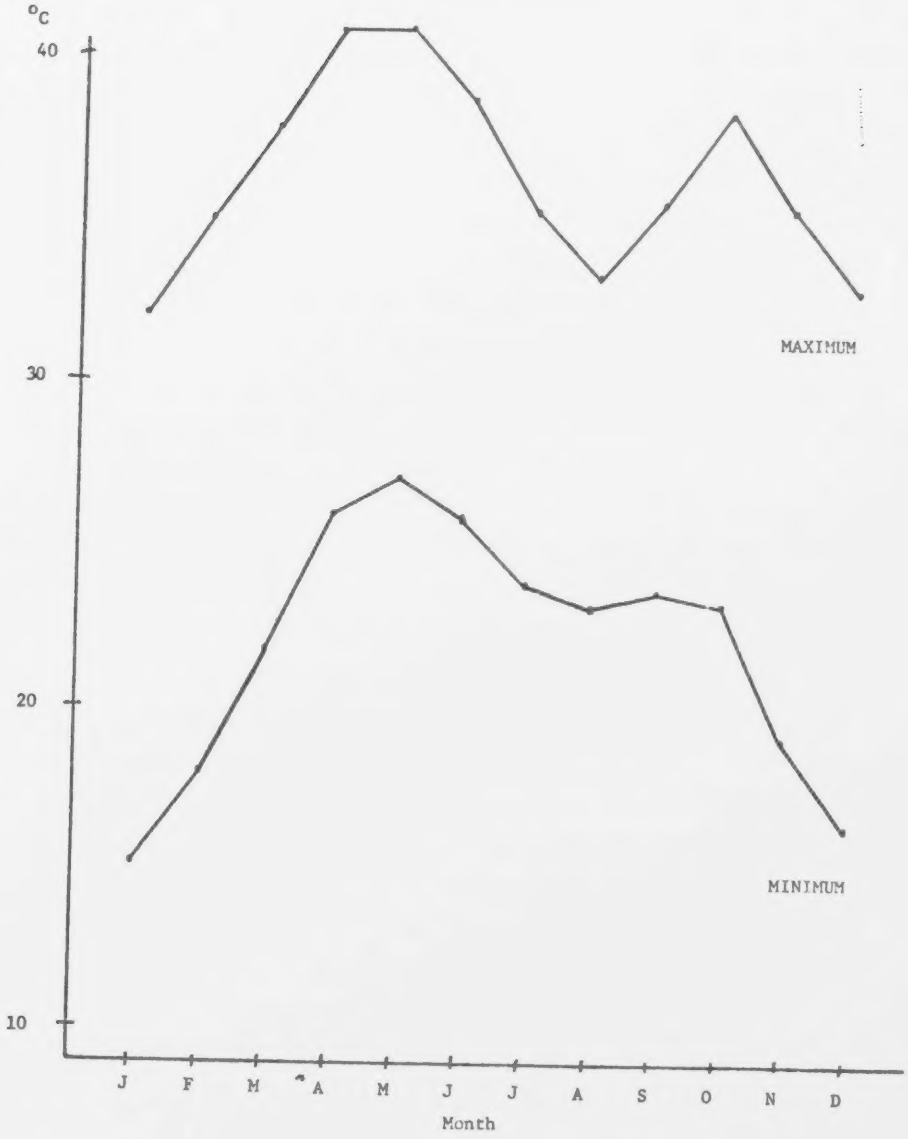
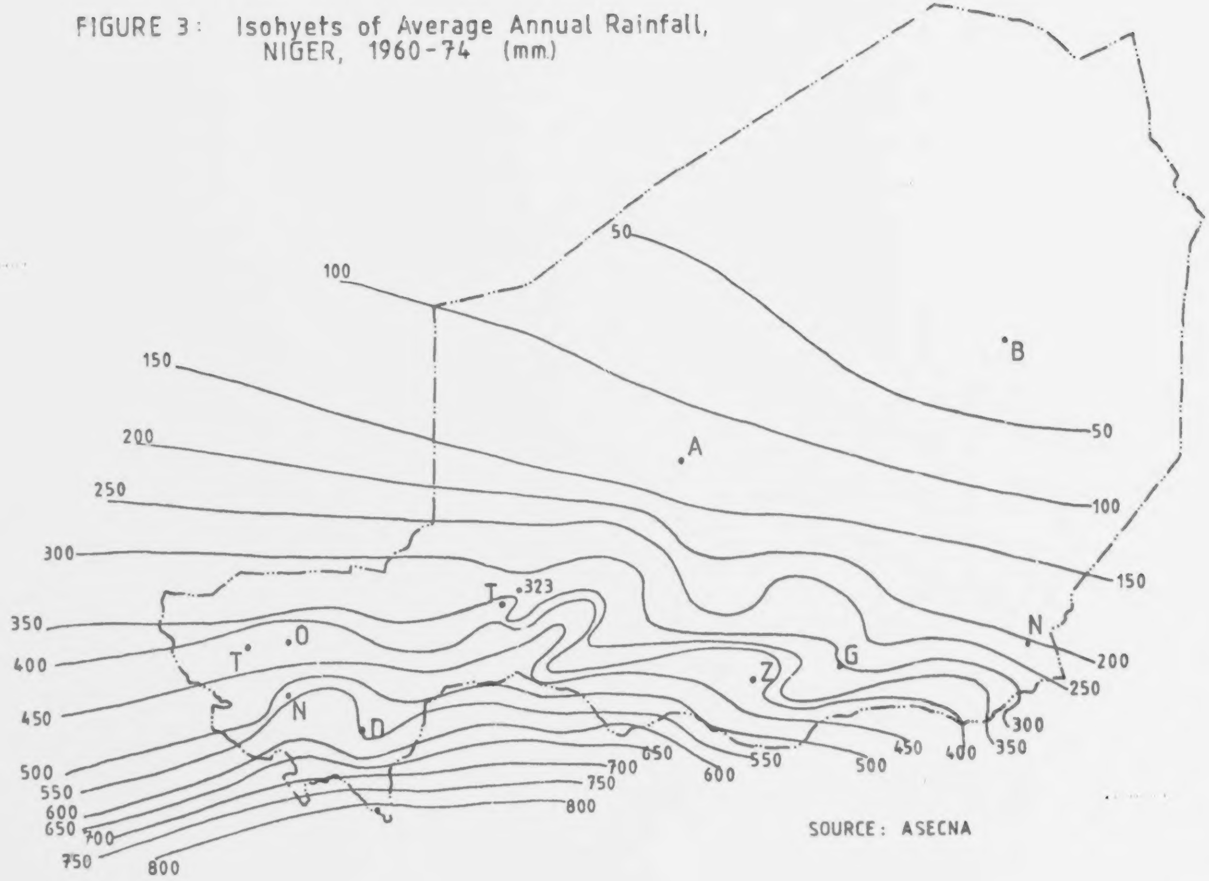


FIGURE 3: Isohyets of Average Annual Rainfall, NIGER, 1960-74 (mm)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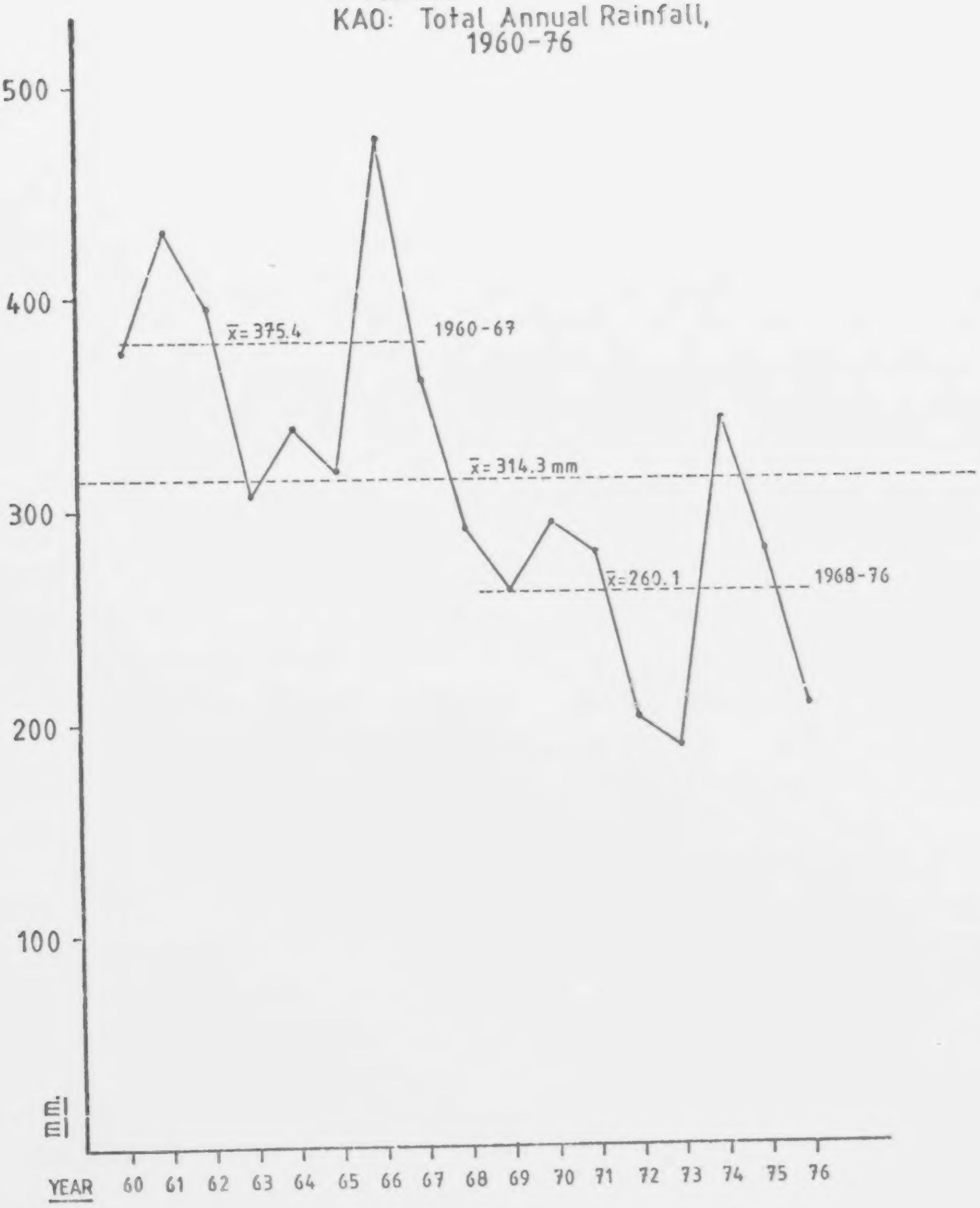
SOURCE: ASECNA

FIGURE 4:
KAO: Total Annual Rainfall,
1960-76



A comparison of the monthly distribution of rainfall at Kao since 1960 with that of the survey year suggests that the survey year may have been peculiar in two respects. First, heavy rains continued to fall later into the year than they had in the previous sixteen years, enabling some farmers to get a second sorghum harvest. Second, no useful rain fell during the last week of June and the first three weeks of July. This month-long drought occurred at the end of May and June plantings, and it devastated the millet crop. These peculiarities, combined with the unpredictability of precipitation in any year, make it difficult to extend the results of the production analysis described below to years other than the survey year.

People and Production Systems. -- Three major ethnic groups populate the Azawak: Tuareg, Haussa, and Fulani. In this context, ethnic affiliation is defined by the household's primary language, be that Haussa, Tamasheq, or Fulfulde. Unfortunately, it is impossible to say with any certainty in what proportion these ethnic groups are represented in the population of the Azawak. The purpose of the latest population census prior to the survey was to determine tax obligations, and therefore, the information collected is of dubious quality. Furthermore, inhabitants of the "nomad zone", which embraces the pastoral zone and the desert, are registered according to "nomad group" and "tribe" rather than place or region of residence. Thus, it is difficult to arrive at quantitative descriptions of the population, other than to say that the vast majority are Tuareg and that, in the southern portion of the region, Haussa households make up the next largest segment of the population.

The mixed farming systems covered by the author's survey could be divided into three groups: Haussa, Village Tuareg, and Bush Tuareg. The attributes of these three "production systems" are compared and contrasted in the third section of this paper. In addition to the mixed farming systems covered by the author's survey, the other major category of agricultural production systems in the pastoral zone could be characterized as nomadic pastoralism. The nomadic pastoralists do specialize in livestock production, relying on markets along the southern fringe of the pastoral zone for grain to supplement their diets. The pastoralists may not be present in areas such as the survey area throughout the year. During the rainy season, they will move to the north to avoid conflicts with farmers over crop damages. During the dry season, they will move south to more permanent water sources and better dry season pastures. Generally, the pastoralists and their herds are in transit through the southern pastoral zone at the beginning of the rainy season and again during the hot wet season which follows the end of the rains.

The category of nomadic pastoralists can be further subdivided to distinguish Tuareg and Fulani livestock producers. The former raise primarily camels and small ruminants. They spend the greater part of the year in the northern pastoral zone. Traditionally, they are members of the more privileged classes of Tuareg society.

Fulani pastoralists produce cattle primarily, often in herds combined with sheep. Based on occasional interviews and time spent among Fulani households, the author determined that during the survey year, the typical household managed a herd of approximately fifty head of cattle. Usually this includes some animals which have been confided to the care of a member of the household, so that the number of animals managed does not always coincide with animal ownership by the household. Although this study does not deal directly with Tuareg or Fulani pastoralists, information concerning their production patterns is introduced where relevant to the analysis.

History. -- Prior to colonization, the Azawak was ruled by Tuareg warlords of the Iwllimeden Confederation, who apportioned the lands of the Azawak among themselves. Each warlord controlled the grazing and water rights in his allotted portion and further subdivided his fiefdom among the vassals and slaves subject to his rule. It was during this period that the ancestors of most of the Bush Tuareg households covered by the survey settled in the survey area to produce grain and pasture their herds. Although nominally they were members of the slave caste (iklan), they were a relatively independent group who owned and managed the productive resources from which they derived their livelihood, subject to the occasional payment of tribute to the aristocracy, a tribute which continues to be exacted to this day. In the pre-colonial era, these households planted some grain by broadcasting seeds on the sides of the dunes, but devoted most of their efforts to livestock production. During the growing season, they would evacuate their animals to northern regions to participate in the salt cure and to allow pastures in the southern pastoral zone to grow out, a practice which has been abandoned in more recent years due to the influx of producers competing for the use of the range.

The Tuareg warlords were subdued by the French Army during the colonial struggle, and their system of land tenure was dissolved. Their subjugation cleared the way for a northward migration of Haussa grain producers into the pastoral zone during the period of abnormally high rainfall from 1948 to 1968. The village of Kao was settled during this period. The migrant Haussa grain producers introduced more intensive techniques involving the clearing of trees and grasses, and as the higher rainfall made grain production more profitable, the area planted to grain expanded rapidly.

During the same period, mechanized deep-bore water pumping stations were opened throughout the pastoral zone. The opening of the pumping stations, combined with the pacification of the Tuareg warlords, attracted a larger number of Fulani herds than the area had supported previously. These herds also grew more rapidly following the implementation of cattle vaccination programs.

Thus, prior to the 1968-1973 drought, the Azawak was subjected to an influx of Haussa grain producers and Fulani cattle herders, whose herds were growing at a greater rate due to the suppression of certain endemic diseases. These developments contributed to the devastating effects of the drought on the people, the animals, and the land resources of the pastoral zone. For example, many of the households designated as Village Tuareg had worked for members of the Tuareg aristocracy as herders prior to the drought. However, their patrons suffered substantial losses of animals during the drought, and these households were forced to move to villages such as Kao, which functioned as emergency food distribution centers. To support themselves, Village Tuareg households turned to commerce or work as laborers for Haussa households, who also had come to rely more heavily on trade as a source of income.

This tendency was furthered by the growth in the importance of Kao and similar villages in the southern pastoral zone as livestock markets. With the reduction in the supply of animals as a result of the drought, continued growth in demand for meat in coastal cities, and the commensurate rise in animal prices in the Sahel, livestock merchants moved to markets further north in the pastoral zone in an effort to obtain more advantageous prices. Thus, the chain of primary animal collection markets serving the pastoral zone has shifted north in recent years. This chain of events can be generalized as follows: (1) pacification of the pastoral zone by colonial forces; (2) the northward migration of grain producers into the pastoral zone during the two decades of abnormally high rainfall which preceded the recent drought; (3) greater growth in the cattle population due to the opening of mechanized water pumping stations and the elimination of endemic diseases; and (4) the emergence of market villages along the southern fringe of the pastoral zone. From this brief introduction to the environment within which the research was conducted, we move to a description of the survey methodology.

Research and Analytical Methodology

Sample Selection. -- The research team, including the author, lived at Kao throughout the course of the survey. The team consisted of three enumerators, a translator whose family lived with the author's family at the research site, two clerks, and several part-time assistants and consultants. The team arrived in Kao after completing the government clearance process in May 1976. At that time, a census of the village and surrounding Tuareg and Fulani encampments was conducted. The census was required to construct a proper sampling frame since, as mentioned above, reliable alternatives were available. To assist with the census and ensure the accuracy of the results, community leaders accompanied the research team.

For the purposes of the census and the survey, a "household" was defined as a group of people who eat out of the same pot. In the case of the populations covered by the survey, this definition delineated a management unit within which all members worked the same fields and tended the same animals. Based on the results of the census, sixty-five such households were selected at random at a public drawing: forty-four from the village and twenty-one from a group of Tuareg encampments approximately five kilometers from the village. Of these sixty-five households, seventeen moved out of the survey area during the course of the survey and had to be dropped from the sample.

Survey Techniques.-- The basic work of the survey consisted of regular twice-weekly interviewing with each sample household. During these interviews, the enumerators collected information on the activities of each household member during the twelve daylight hours of each day, household cash flows during the relevant three or four-day period, exchanges in kind, production of agricultural commodities, and consumption of grain, meat, and milk. The enumerators then coded this information, using a coding system which was devised during the first month of the survey. Coding was verified weekly. The data then were punched directly from the questionnaires onto computer tape.

Each of the plots planted by sample households during the 1976 growing season was measured. The resulting angle/distance measurements were then spot-checked and coded by the author, so that the area of each plot could be calculated by computer. The results were returned to the author so that fields could be remeasured as necessary.

The measurement of agricultural output was based on local units of measure. For instance, since the grain harvest is stored on the head in bundles, the output from each field was marked down in bundles. Then, a representative sample of bundles of each type of grain was obtained from a number of households and the grain was removed from the head using the local processing methods. The bundle was weighed on a spring scale prior to processing, and the resulting quantity of grain was weighed on a balance scale.

Finally, market surveys were conducted to determine the prices at which to evaluate output. A sample of retail quantities of grain was purchased at each weekly market, then each purchase was weighed on a balance scale to determine the price per kilogram. Also, one or two enumerators remained in the livestock market throughout the day and, for as many transactions as possible, recorded the purchase price, age, sex, breed, origin and destination of the animal, and occupations of the buyer and seller. These data were compiled and coded on market survey schedules, and, again, keypunching was done directly from these schedules.

Populations Covered by the Survey.-- As mentioned in the first section, the survey was restricted to mixed farm households. Some qualititative interviewing was conducted by the author at traditional gatherings of nomadic pastoralists in or around the survey area. However, such research was really tangential to the main survey.

The main survey covered the three types of mixed farm households discussed above: Haussa, Village Tuareg, and Bush Tuareg. In addition, the sample contained three Fulani households. However, since this subsample was too small and the households within it were not found to be representative of any major production system, these three households have been dropped from the subsequent analysis. The forty-five households remaining represented the three types of production systems in the following proportions: (1) Haussa: sixteen households: (2) Village Tuareg: seventeen households; and (3) Bush Tuareg: twelve households.

Analytical Methodology. -- The linear programming model presented in the sixth section of this paper applies directly to the production system represented by the twelve households in the Bush Tuareg subsample. From among the populations covered by the survey, the model was designed to represent the production system of Bush Tuareg households, for several reasons. First, Bush Tuareg households relied most heavily on household production as a source of food for subsistence needs. Second, from among the three subsamples, they derived the largest proportion of their cash income from agricultural enterprises, as opposed to commerce or wage labor, during the survey year. Third, Bush Tuareg households devoted the largest proportion of available labor resources to agricultural enterprises. Fourth, they relied least on hired labor to supplement household labor resources. These characteristics will be illustrated in the comparative analysis of the three production systems following this section. Finally, and most imporantly, based on the author's travels and life in the southern Azawak, on what little population data were available, and on secondary sources, the author concluded that the households in the Bush Tuareg subsample were the most representative of the largest segment of the population of mixed farmers in the southern Azawak. This segment could be characterized as semi-sedentary Tuareg subsistence crop and livestock producers, most of whom are of the iklan social class.

The model allows for selection among millet, sorghum, goat, and mixed goat and cattle enterprises, subject to labor, land, and subsistence constraints and certain other behavioral assumptions to be specified below. The model is then used to determine optimal enterprise combinations for both the average and large Bush Tuareg households. Separate solutions are obtained for the larger households, since only the larger households were engaged in cattle production during the survey year. In determining optimal enterprise combinations, the model is used to test the effect of the three policies mentioned above, all of which are designed to encourage specialization in cattle production. The results suggest that such policies would not be wholly effective without complementary policies which would relieve labor constraints in the harvest and pre-harvest periods and which would preserve the value of forage resources during the rainy season, thus preventing the permanent degradation of the range. One such complementary policy, that of protected forage cultivation, is discussed in the final section of the paper.

Applicability of Results. -- The analysis applies directly to a cross-section of Bush Tuareg mixed farm households in the southern Azawak in a year in which, in addition to the other parameters in the model, the amount and distribution of rainfall was as observed during the survey year. This latter consideration is particularly important, since varying amounts and spatial and temporal patterns of rainfall would alter the labor requirements and possibly the relative profitability of agricultural enterprises. Thus, the model is useful for cross-sectional comparisons, but given the extensive variability of rainfall patterns in the southern pastoral zone, the model could not be used reliably to predict or explain behavior over time.

The model assumes perfect foresight on the part of producers, who base their decision-making on known prices, labor requirements, and risk parameters. In actuality, producers probably select the size and combination of agricultural enterprises on the basis of expectations formulated from experience over a number of years, not simply one year. The following interpretation of the model assumes that producer expectations concerning the parameters of the model did not deviate substantially from estimates of the parameters derived from data collected by the research team during the survey year. Only if it can be assumed that such expectations are constant over time, which is doubtful, could the model be used successfully for intertemporal comparisons. A more realistic formulation, which could explain behavior over time, would be to assume that expectations vary in some predictable fashion based on variations in rainfall patterns. The author hopes to test this formulation in future research.

Monetary Units. -- The unit of account throughout this report is the franc CFA (designated as FCFA), the official currency of much of former French West Africa, including Niger. The franc CFA is supported by the French banking system and guaranteed parity with the French franc at a rate of 100 (CFA) to 1 (French). During the survey year, the official exchange rate for the franc CFA varied from 222 to 246 F CFA per dollar.

Comparison of Production Systems Surveyed

This section of the report compares the agricultural enterprises undertaken by the three major subsamples: Haussa, Bush Tuareg, and Village Tuareg. Although most of the subsequent analysis dwells on Bush Tuareg households, information on other households is presented here by way of contrast since such households do form a significant proportion of the population of the southern pastoral zone, although they are not in the majority. Statistics relevant to the three Fulani households in the survey sample also are presented, but these statistics will not be discussed herein, and the reader is cautioned that such statistics may not be representative of most of the Fulani households in the pastoral zone. In comparing the three major production systems, the following discussion dwells on labor patterns and availability, land use, livestock management, and the output and consumption of agricultural products.

Labor Patterns and Availability.-- Table 1 presents summary statistics by subsample on labor availability, area planted, and grain and milk production. Labor availability, presented as the number of working resident equivalents, signifies that one household member of at least eight years of age was present in the household for the entire year. Thus, a working household member who was present in the household for only nine of the twelve survey months would register as .75 resident equivalents. The conversion to resident equivalents was found to be desirable since individuals travel extensively in the pastoral zone and there was a great deal of movement into and out of households.

As Table 1 indicates, the twelve households in the Bush Tuareg subsample had, on the average, the greatest number of family members of working age residents in the household. In contrast, Village Tuareg households had the least amount of working age labor available. Ten of the seventeen Village Tuareg households had less than three resident equivalents during the survey year, whereas only four Haussa and four Bush Tuareg households fell within that category. On the average, including children under eight years of age, household size varied among the three subsamples from five to seven resident equivalents of all ages. Haussa households had the greatest number of children under eight years of age in residence.

The outstanding characteristic of the statistics presented in Table 1 is that, as the ranges indicate, the underlying distributions display an enormous degree of dispersion. Curiously, an analysis of the data indicated that variations in grain and milk production are not highly correlated with variations in labor availability. This suggests that other factors, such as access to land and the use of hired labor, must be considered in explaining variations in agricultural production.

The statistics in Table 1 also suggest that Village Tuareg households were not only relatively smaller than households in the other subsamples, but they were also the least successful agricultural producers. They planted

TABLE 1

LABOR AVAILABILITY, AREA PLANTED AND GRAIN AND MILK PRODUCTION[a]

Statistic	Units	Haussa	Village Tuareg	Bush Tuareg	Fulani
Labor Availability	resident equiv./household				
Range		1.37 - 8.33	1.83 - 3.82	1.94 - 7.74	1.89 - 7.66
Mean		3.82	2.74	4.27	4.14
Area Planted	ha /household				
Range		2.29 - 49.62	.82 - 5.31	.96 - 13.90	1.36 - 8.52
Mean		8.67	2.74	5.18	4.25
Grain Production	kg /household				
Range		33 - 2912	0 - 481	0 - 16,250	0 - 104
Mean		580	164	2348	45
Milk Production	liters/household				
Range		0 - 379	0 - 988	70 - 2465	0 - 1045
Mean		56	170	761	599

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[a] Data from Appendix IV, Eddy monograph

less land and harvested less grain than either of the two major subsamples. Haussa households planted the greatest land area to grain, but they were not on the average the most successful grain producers. Most of the land planted to grain by Haussa households was upland soil planted to millet. In contrast, most of the area planted by Bush Tuareg households was in the lowlands and was planted to sorghum. Bush Tuareg households were the most successful grain producers, partially because sorghum was a more successful crop than millet during the survey year.

The figures on the following pages show a breakdown for each subsample of the allocation of labor throughout the year by five major activity groupings: crops, livestock, commerce, domestic work, and rest. Labor use in each category is measured by the average number of hours per fortnight (two-week period) allocated to each category by working household members. The total amount of labor available, on the average, for each fortnight is indicated by the top line of each graph. In calculating labor availability, it is assumed that household members will work up to a maximum of twelve hours per day.

Figure 5 gives the breakdown of labor use by Bush Tuareg households. The most noticeable seasonal difference in labor use is the drop in labor allocated to livestock during July and August, which is the growing season for grains. During the same period, labor allocated to crops increases sharply, and household members take less than an average of three hours of rest during the daylight hours of each day. Labor allocated to crops rises again during the harvest season in October, a time when the amount of labor allocated to livestock has also increased relative to the growing season. The total amount of labor available rises slightly during the growing season and the harvest season.

The labor patterns of a representative Bush Tuareg household can be summarized as follows: In the dry season, which runs through the first five months of the year, there are four people of working age present in the household: an adult male and female and a younger girl and boy. The woman and the young girl each spend six hours a day on domestic tasks. The man and the young boy tend the animals for five or six hours of every day, and once a week the entire family visits the weekly market.

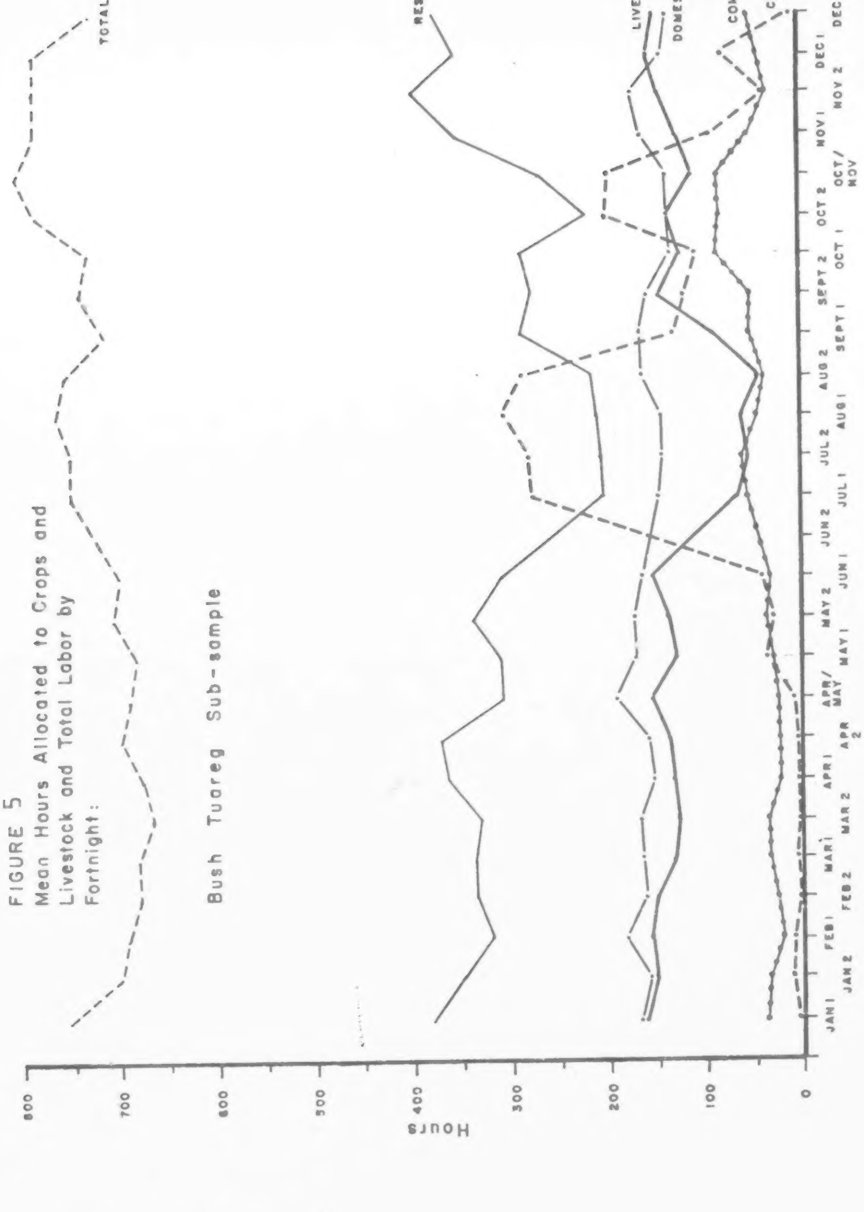

FIGURE 5
Mean Hours Allocated to Crops and Livestock and Total Labor by Fortnight:

Bush Tuareg Sub-sample

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Labor in the fields begins in late April, and the entire family devotes correspondingly less time to rest and to the animals. A male family member returns to the household in June as the rains begin and as crop production begins in earnest. During July and August, the animals are left to the young boy, who devotes four hours a day to their care. The women continue with the domestic work, but in addition, they assist the men for two hours a day in the fields, as does the young boy when he is not working with the animals. Each of the men devotes an average of eight hours a day to crop production at this time. This combination of activities leaves just enough time during the daylight hours of each day for the family to eat their meals. In order to free up more time for social activities, the household may hire labor to assist with the work in the grain fields.

After the final weedings are completed in the grain fields in late August, one of the adult household members travels to visit a relative. The adult male devotes more time to assisting the young boy with the animals, since extra care is required at this time in order to keep the animals away from the enticing heads of grain.

As the harvest begins, each of two household members must continue to spend six hours per day with the animals in order to keep them out of the fields, and each of the two women still are confined to six hours a day of domestic chores. Commercial activities take up another three hours a day of the family's available labor time in addition to the time spent in the weekly market, since the supplemental income derived from crafts is required to finance grain purchases at a time when stocks are low. Each family member requires three hours each day to eat his meals. This leaves approximately fourteen hours each day for harvesting from the household's entire available stock of labor of sixty hours per day. In some cases, that fourteen hours - amounting to only two or three hours labor per day per working household member - is not enough labor to evacuate the grain to storage areas before animals, birds or rodents reach it. The problem is further exacerbated by herds returning from the north who are anxious to rejoin their dry season pastures. By November, the harvest is completed, and as visitors leave the household in late December, the household returns to its more regular dry season labor schedule.

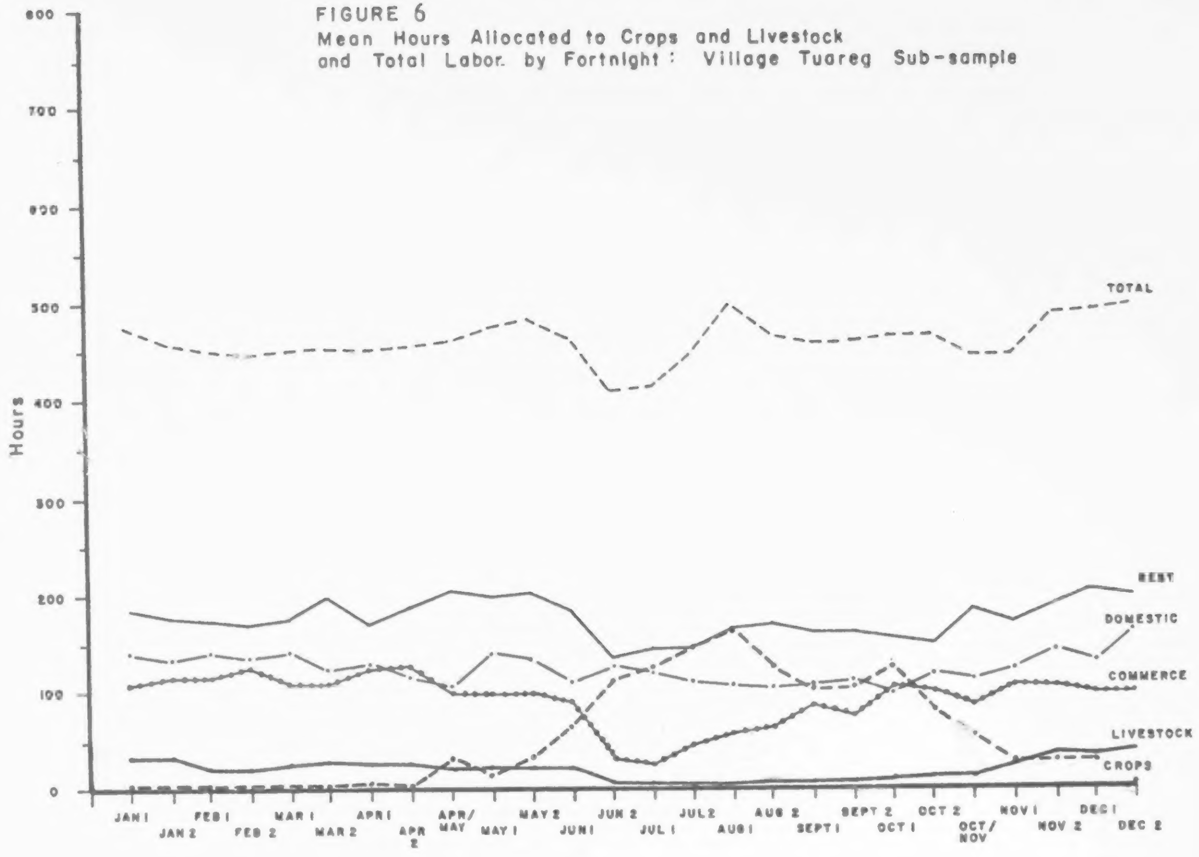
Figure 6 indicates the patterns of labor allocation for the average Village Tuareg household. The most obvious difference between this and the previous graph is that, relative to Bush Tuareg households, Village Tuareg households have much less available labor. An additional difference is that the average Village Tuareg household devotes more time to commerce, which includes time spent on crafts, on sales, and on wage labor. Time devoted to commerce declines as time devoted to crop production increases during the growing season, indicating the same sort of trade-off as exists between crop and livestock activities at that time among Bush Tuareg households.

Village Tuareg households devoted very little time to livestock enterprises. Only three of the seventeen households in the subsample owned and managed animals throughout the survey year. These households also devoted relatively little time to crop production. The main source of their livelihood was income derived from sales of crafts and services. Thus, aside from commerce and domestic activities, little time was left over for agricultural enterprises.

Labor allocation in a representative Village Tuareg household may be described as follows. A typical household has five full-time members: an elder man and woman, teenage child, and two younger children. During the dry season, which spans the first five months of the year, the woman and the teenage child each spend four to five hours per day on domestic chores. The man spends two hours each day tending animals owned by wealthier village residents. During this period, the man and woman each spend four hours of every day working as hired laborers, tending small stands in the marketplace, or making crafts for sale to supplement the household's income.

In late April, the woman takes time away from domestic work to assist the man in planting the small millet field which has been loaned to them by more wealthy Haussa village residents. As the rains begin in June and crop production activities pick up, time allocated to commerce declines and remains at a low level until late July. From late July through August, the man undertakes work in the fields owned by Haussa village residents while continuing to work on his own fields. In October, as the harvests come in, the woman once again takes time away from domestic work to assist with the transport of the grain. While he is harvesting his own fields, the man de-

FIGURE 6
Mean Hours Allocated to Crops and Livestock and Total Labor by Fortnight: Village Tuareg Sub-sample



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votes more time to commerce during a period when the markets are active. As the harvest is completed in November, the dry season work patterns are resumed.

Figure 7 illustrates the average labor patterns of Haussa households. The distinctive feature of the Haussa production system as regards the labor input is that seasonal crop production activities do not detract significantly from time spent on any other productive work category. This is because the hiring of labor relieves any possible constraint due to crop production activities during the June through August period. This is evidenced by the sharp increase in total labor availability during that period. During July, households in the Haussa subsample hired an average of twenty hours per week of labor services. The amount of labor hired rose to seventy-five hours per week during August, which was the month when the maximum amount of rain fell and crop weeding labor requirements were at their peak. The household also was assisted during the crop cycle by the return of the young men who had sought work in urban centers during the dry season. Furthermore, the increase in water sources during the rainy season enabled household members to spend less time on domestic work and more time assisting laborers in the fields. The combined additions to the household labor force provided sufficient labor for crop production so that other activities could continue uninterrupted. Working household members were able to engage in non-productive social activities for an average of at least 4.5 of the twelve daylight hours of every day throughout the growing season.

Having assisted their families with the most arduous crop production tasks (weeding), the young men began to leave the village again in early October as the harvest period started. Haussa households also reduced the amount of labor hired at this time. There was a resultant drop in labor availability, but during the survey year, Haussa households had an average sufficient labor to cover harvest activities and the increase in commercial activities prompted by the active November markets without hiring additional labor or reducing rest activities below a level which allowed for an average of over four hours of rest daily per working household member.

Figure 8 indicates the percentage of available labor allocated to agricultural production in each fortnight of the year by each subsample. As

FIGURE 7
Mean Hours Allocated to Crops and Livestock and Total Labor by Fortnight: Haussa Sub-sample

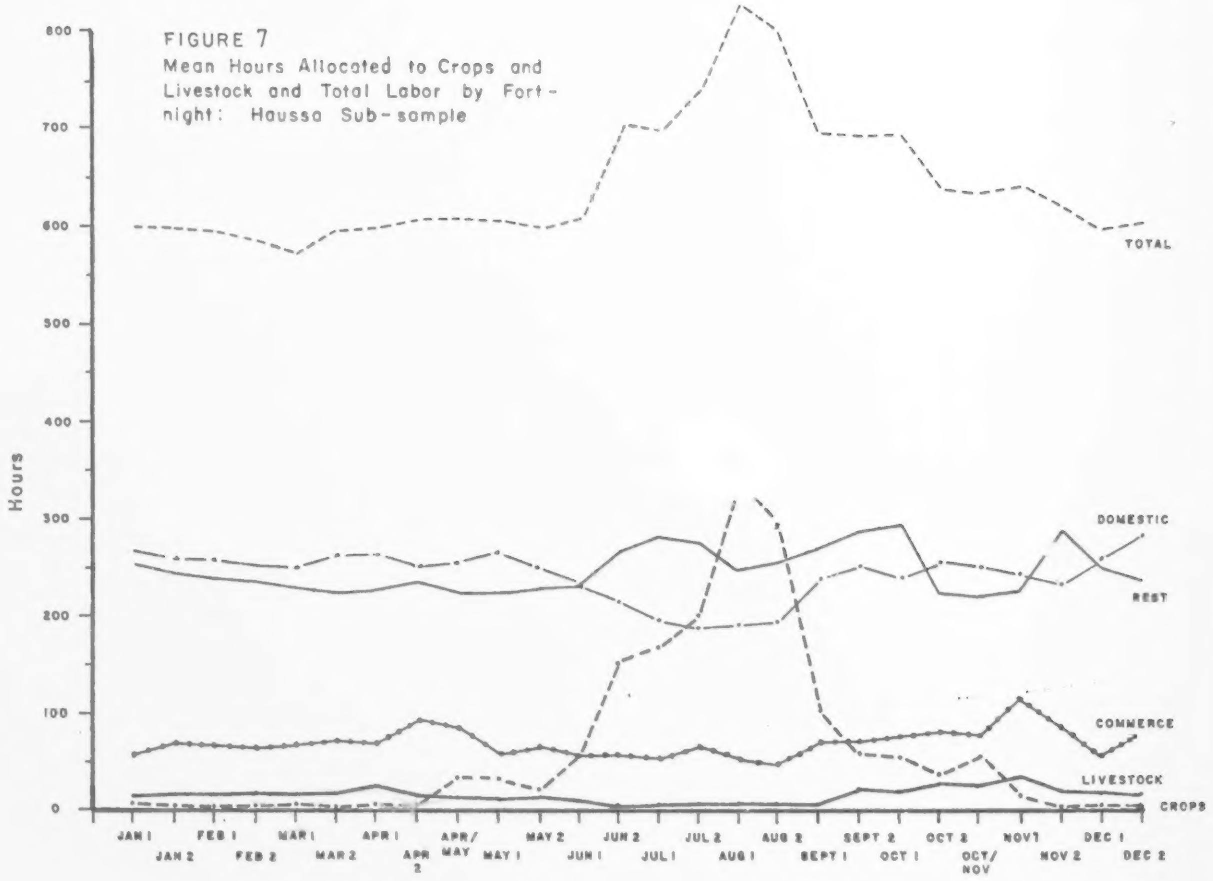

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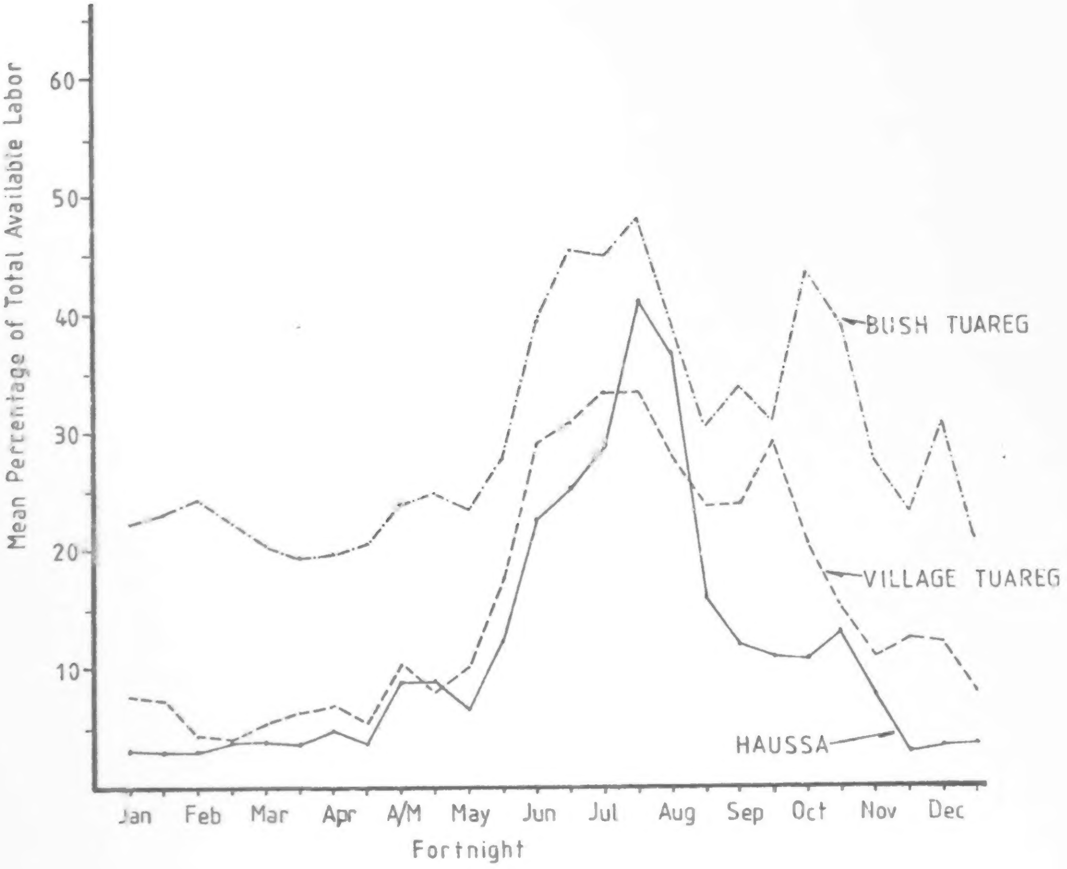
FIGURE 8 : Percentage Allocation of Labor to Agricultural Production



suggested by the above analysis, activities related to agricultural production were most important among households in the Bush Tuareg subsample. The average Bush Tuareg household devoted between 20 and 50 percent of available labor to agricultural production throughout the year. This was not the case among village residents (Haussa and Village Tuareg subsamples) who devoted less than 10 percent of available household labor to agricultural production outside of the June to October crop cycle. This is consistent with the description of Bush Tuareg households as subsistence producers who devoted more time to agricultural enterprises, in contrast to Village Tuareg and Haussa households, whose members devoted relatively more time to commerce and relatively less to either crop or livestock production.

Land Use and Grain Output. -- The only officially recognized form of private ownership of land by the individual household in the southern pastoral zone is the right of the grain producer to recover compensation for damages inflicted by herds trespassing on plots planted to grain. No similar individual rights in land are extended to the livestock producer. The land input to livestock production is a public resource and pasture is therefore available on a "first come, first served" basis. Despite a 1961 law which was intended to discourage grain production in the pastoral zone, grain producers still are able to obtain private rights in the land by clearing a plot and planting it to grain. The effect of these policies is to encourage the individual to make improvements in the land which enhance its quality as an input to grain production, but no similar incentive exists for the individual to improve the land for use as an input to livestock production. Furthermore, the recognition of private property rights in land allocated to grain production, but not in land allocated to livestock production, probably encourages the expansion of grain cultivation.

Since land available as an input to livestock production is open to the public, it is difficult to estimate the quantity of the land input to livestock enterprises. However, the research team did obtain measurements of all plots planted to grain by sample households during the survey year. Each household planted from one to four plots, and each plot contained millet, sorghum, or some combination of the two. In addition to the two major grain types, some households also intercropped cowpeas or gumbo (okra). This was particularly true of households in the Haussa subsample, but intercropping was not practiced by Bush Tuareg households. Since the quantities and value of the cowpea and gumbo harvests were insignificant relative to the grain harvest during the survey year, the following analysis considers only the production of the two major grain types.

Production statistics for millet and sorghum are presented in Tables 2 and 3. Millet was grown as a rain-fed crop and was planted primarily in upland, sandy soils. In contrast, most of the sorghum crop was planted in the alluvial, predominantly clay soils in the runoff channels which carry water from the surrounding hills. The tables indicate that millet cultivation was less labor-intensive than sorghum. For all three major subsamples, the mean number of hours applied per hectare to millet fields was approximately half the per-hectare labor input to sorghum fields.

Millet production per household varied widely. During the survey year, households in the Haussa subsample appeared to be more successful millet producers than other households, particularly those of the Bush Tuareg subsample. Mean millet production per Haussa household was 189 kilograms, whereas only one of the twelve Bush Tuareg households harvested any millet, and that harvest amounted to only 90 kilograms.

Although Haussa households appeared to be more successful millet producers, the statistics in Table 2 suggest that Bush Tuareg households were the most successful sorghum producers. The twelve households in that subsample accounted for 78 percent of total sorghum production by the forty-five sample households. One Bush Tuareg household produced an extraordinary harvest of over sixteen metric tons of sorghum. Average sorghum production among the other nine households in that subsample who had some harvest was 1,315 kilograms. This was more than twice the average production by Haussa sorghum-producing households and ten times the average production by the Village Tuareg households which planted sorghum.

The median area planted per household to all crops was approximately three hectares, and the median area per plot was between 1.0 and 1.5 hectares. This excludes four households which planted over ten hectares each; these four households included three successful Haussa merchants and a Tuareg camp chief.

TABLE 2

MILLET PRODUCTION STATISTICS BY SUBSAMPLE

Statistic (Per Household)		Subsample Haussa (n=16)	Village Tuareg (n=17)	Bush Tuareg (n=12)
Total Area Planted (Ha.)	Mean	7.40	2.15	2.99
	Range	.74 - 47.30	.19 - 4.05	.32 - 6.88
Total Labor (Hours)	Mean	1224	833	498
	Range	408 - 3020	36 - 2467	136 - 1097
Total Grain Produced (Kg.)	Mean	189	73	7
	Range	0 - 604	0 - 248	0 - 90
Hours/Ha.	Mean	258	436	212
	Range	64 - 589	60 - 1132	54 - 734
Kg./Hour	Mean	.13	.10	.01
	Range	.00 - .34	.00 - .29	.00 - .08
Kg./Ha.	Mean	46	39	1
	Range	0 - 136	0 - 159	0 - 17

SOURCE: Appendix V, Labor and Land Use on Mixed Farms in the Pastoral Zone of Niger, Center for Research on Economic Development and USAID, 1979.

TABLE 3

SORGHUM PRODUCTION STATISTICS BY SUBSAMPLE[a]

Statistic (Per Household)		Haussa (n=14)	Village Tuareg (n=12)	Bush Tuareg (n=12)
Total Area Planted (ha.)	Mean	1.38	.75	2.26
	Range	.20 - 3.34	.13 - 1.68	.31 - 7.90
Total Labor (Hours)	Mean	579	544	1592
	Range	163 - 1365	24 - 1821	297 - 3670
Total Grain Produced (Kg.)	Mean	444	128	2341
	Range	0 - 2066	0 - 435	0 - 16250
Hours/Ha.	Mean	413	765	895
	Range	105 - 792	154 - 1917	412 - 2137
Kg./Hour	Mean	1.08	.22	1.02
	Range	.59 - 1.51	.00 - .66	.00 - 4.43
Kg./Ha.	Mean	373	146	731
	Range	0 - 637	0 - 345	0 - 2057

SOURCE: Appendix V, Labor and Land Use on Mixed Farms in the Pastoral Zone of Niger, Center for Research on Economic Development and USAID, 1979.

[a] Statistics based on data for those households which cultivated sorghum, as indicated by the subsample size.

It is possible that the four households planting abnormally large plots were encouraged to do so by the prevailing system of land tenure. As mentioned above, individual property rights vested when an area was cleared and planted to grain. Such rights enabled the owner to bring suit against the herder whose animals had encroached upon the field. These rights could be defeated only by failure to plant the field in subsequent years.

Crop damage suits were brought before the local Haussa village chief, a forum which was generally unfavorable to the herder. If the Haussa village chief finds for the grain producer, as is the outcome in most such cases, he then awards damages based on the number and type of animals that are found to have entered the field and whether the animals are found to have entered during the daytime or at night. Judgments are enforced by armed nomad guards who are stationed in villages such as Kao during the growing season.

When a satisfactory conclusion is not reached at the village level, the suit may be referred to the office of the Sous-Préfet, or regional governor. The influence of Haussa merchants with the regional administration and the predominance of Haussa civil servants in the government also provides a favorable atmosphere for the crop producer in the event of a referral.

Property laws in Niger, as they were explained to this author by a local government official, also recognize a more permanent interest in land than that mentioned above, once a household has planted a given plot to grain for three consecutive years. The ability to acquire a more permanent vested interest in land merely by continuing to plant grain is an additional incentive to continue grain cultivation, even though the producer may have an alternative source of income from trade which makes the cultivation of grain for subsistence unnecessary. The rights accompanying this interest may be defeated by failure to plant during each successive growing season, but there is no requirement that the individual asserting these rights continue to cultivate the entire field through to harvest in order to maintain his rights to the entire parcel. The condition that the owner continue to plant may be fulfilled by hiring laborers to plant and weed for the first few months of the season, thus avoiding the need to allocate household labor to these tasks. Then, once the plants have sprouted, the farmer can abandon the field altogether while maintaining his interest in the land and his right to an action for damages if trespassing herds encroach upon it.

The combined effect of these practices is to encourage the expansion of grain cultivation without stimulating either grain or livestock producers to improve the land or to prevent environmental degradation. Furthermore, the current system for enforcing the limited private property rights that exist appears to favor the grain producer at the expense of the livestock producer. These problems will be discussed further at the conclusion of this paper.

Livestock Output. -- Several types of animals are raised in the southern pastoral zone, including goats, cattle, donkeys, horses, camels and sheep. In addition, many families living in villages raise poultry as a supplemental source of protein. Poultry production was not a common activity among households living outside of the village.

Donkeys are used as work animals, primarily for hauling water, grain and firewood. In addition, they are the southern pastoral zone's most popular form of personal transport. They are considered to be versatile and hardy animals, withstanding the harshest of environments. Donkeys are particularly indispensable to households living outside of the village, such as those of the Bush Tuareg subsample. Accordingly, within the survey sample, donkey ownership was concentrated among Bush Tuareg households.

Camels also are used for transport, but they are more expensive animals, and their ownership is the prerogative of wealthier households. Camels also are raised for their milk. Although not as hardy as donkeys, they do have a wider range of grazing options in that they can browse the tops of trees as well as low brush.

Horses, like camels, are a more prestigious form of personal transport reserved for wealthier households. Only the six most affluent households in the survey sample owned horses.

Among sample households, sheep were raised primarily for meat. Most often they were raised for slaughter at special occasions, such as marriages, baptisms, and other festivals. Sheep production was most concentrated among members of the Haussa subsample. None of the sheep herds held by sample households included more than ten head.

Goats were the animals most commonly held in sample members' herds. In terms of number of head, they far outnumbered any other animal type in all but the smallest of herds managed by sample households. There are several reasons why sample households -- and Tuareg households in particular -- preferred goats over other animal types: like donkeys, goats are resistant to climate stress; goats are easy to manage and entail less risk than the larger animals; and goats are less expensive to acquire. Furthermore, the rapid growth rate of the herd relative to other animal types means that less time is required to build up a herd which is of sufficient size to provide milk and meat for the household. In the survey sample, goats were held by all of the Tuareg households which owned any animals. Goats were the primary source of milk and meat for these households.

Cattle were the second most important source of milk for household consumption. However, less than one-third of the households in the survey sample owned or managed cattle at some point during the survey year, and the largest of these herds was only ten head. Although cattle do supply substantial quantities of milk, they are more costly animals, and greater risk is involved in their management. For this reason, Tuareg households prefer to build up and maintain a subsistence herd of at least twenty goats before diversifying into cattle production.

Of the types of animals owned by sample members, the remainder of this paper concentrates on goats and cattle, since these animals figured most prominently in sample members' herds. These two animal types were especially important among the herds of Bush Tuareg mixed farmers, the target group of the linear programming analysis. In addition to their importance in numbers, cattle and goats provided most of the milk and meat consumed by sample households. Although camels were an alternative source of milk, only five sample households were engaged in camel production during the survey year. Sheep were an alternative source of meat, but, as indicated above, their ownership was restricted to Haussa households, which had small herds held mainly for slaughter at festivals.

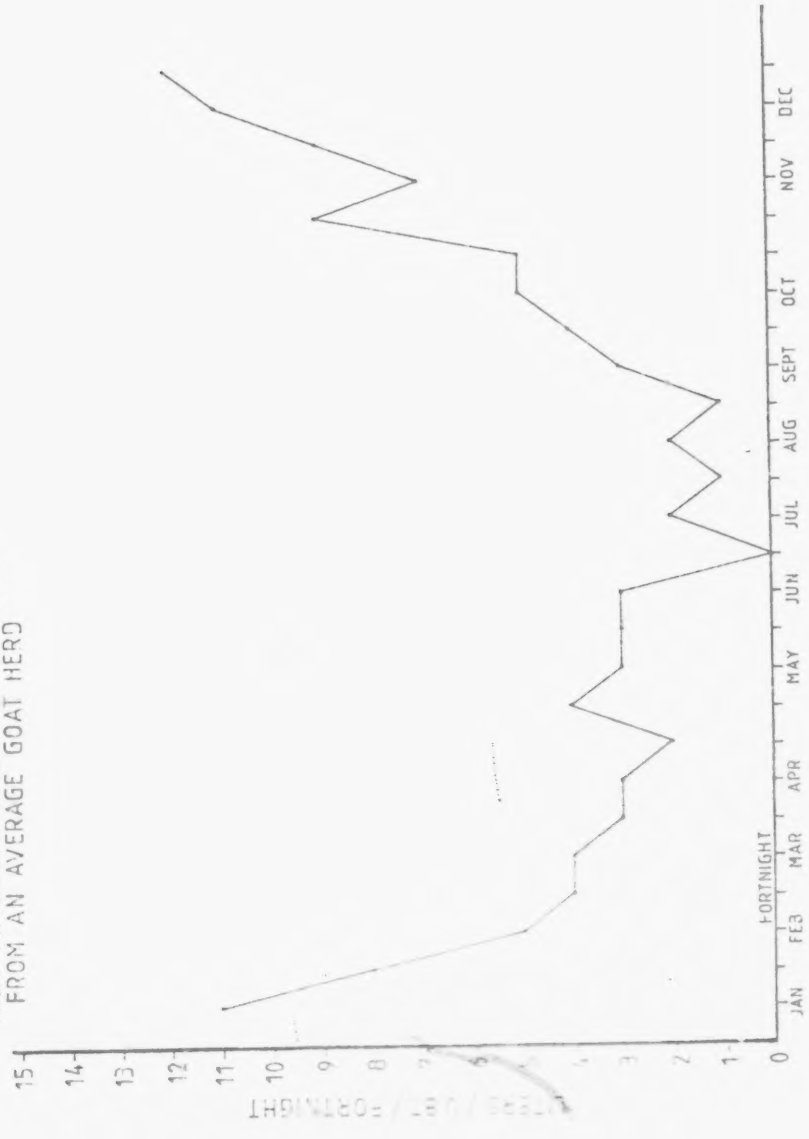
For the purposes of the linear programming analysis, two livestock production activities are considered. The first involves raising goats alone, and the second combines cattle with goats. Cattle production is not considered as an independent activity, since all sample households which produced cattle also produced goats, and the labor inputs to the production of one animal type were inseparable from inputs to the production of the other.

A standard animal unit was used as a basis for comparing the goat herd and the combined herd in terms of labor requirements and output. The unit employed was the Tropical Bovine Unit (Unité Bovine Tropicale, or U.B.T.), which is roughly equivalent to an animal with a live weight of 250 kilograms. Thus, either 5 goats or 1.2 head of cattle constitute one U.B.T.

For sample households, milk production was the most important output from livestock enterprises, and in terms of milk production, the diversified herd of cattle and goats has several advantages over a herd containing goats alone. The average patterns of milk production per fortnight and per animal unit for a sample of four goat herds and a sample of four mixed herds of cattle and goats are shown in Figures 9 and 10. Milk production for the average goat herd is lowest during the rainy season (June through September). This is because females come into heat at the beginning of the rainy season, kid at the end of the rainy season, and produce milk until the onset of the hot, dry season (late February). Although this reproductive cycle is convenient for survival of the young, the timing of milk output provides a complementary food source to grain when it is least needed. Most females reach the peak of their lactation cycle just at the end of the grain harvests, when grain is most plentiful. However, during the growing season, when grain stocks are low and energy expenditure by the household is high, milk production from the goat herd drops to its annual low.

In contrast to this pattern, the mixed herd of cattle and goats produces more milk per animal unit throughout the year and reaches peak production during the time when milk is most needed as a complementary food source. During August, when grain stocks are lowest and the amount of human energy required for crop production is highest, a mixed herd consisting of seven animal units (eighteen goats and four head of cattle)

FIGURE 9 :
MILK PRODUCTION PER ANIMAL UNIT
FROM AN AVERAGE GOAT HERD



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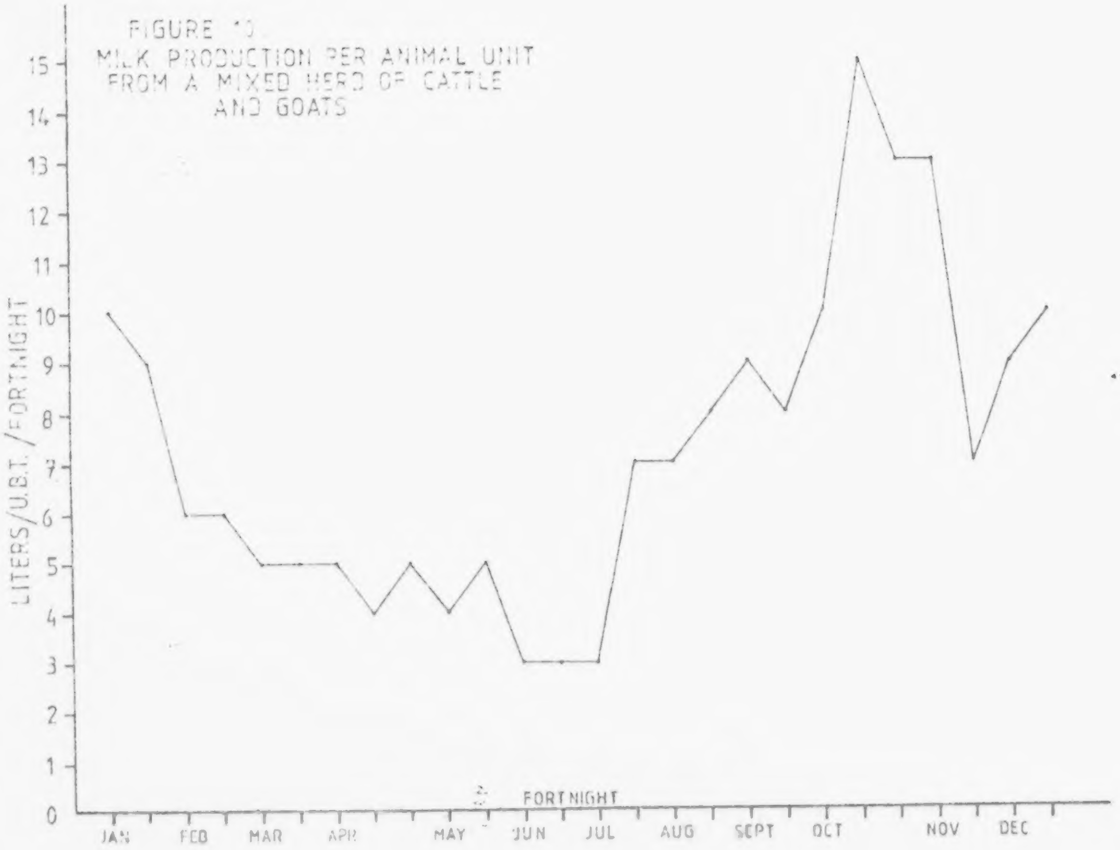

FIGURE 10

MILK PRODUCTION PER ANIMAL UNIT FROM A MIXED HERD OF CATTLE AND GOATS

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would provide at least three liters of milk per day to the household. Since the goats come into milk as milk production from the cattle component of the herd begins to drop off, the mixed herd could provide more than three liters per day to the household for at least half the year (mid-July to mid-January).

In contrast, a comparable level of production could be sustained by a herd of seven animal units of goats (thirty-five goats) during only three months of the year (November through January). Furthermore, the total amount of milk output from the mixed herd is approximately 50 percent greater per animal unit than that from the goat herd. Average annual milk production from the four mixed herds of cattle and goats was 189 liters, whereas the four herds containing only goats produced an average of 124 liters per animal unit.

In order to estimate the producer's expected return to his annual labor input to livestock production, two types of "output" must be evaluated in addition to the value of milk output. The first is the appreciation in value of animals held in the herd. The second is the value of young born alive into the herd during the year and surviving at the end of the year. The result is a more accurate measure of the expected return to labor than would be provided by profits from animal sales alone.

The appreciation in value of an animal held in the herd is measured by the change in the market price of the animal as a result of its growing one year older. The prices used to evaluate this component of livestock output are discussed in subsequent sections of this paper. To estimate the expected return, the gain represented by change in price must be discounted by the risk that the animal will die or otherwise be lost from the herd during the year in question. Similarly, the value of young born into the herd must be discounted by probabilities of survival.

The results for the two types of livestock production activities (goats and cattle combined with goats) are presented in Tables 4 and 5 . The cost per animal unit of salt purchased during the year has been deducted, salt having been the only purchased input of significant magnitude. The results show that the expected return from holding animals in the herd is much lower than either the value of surviving young or the

TABLE 4

EXPECTED VALUE OF OUTPUT PER U.B.T. OF GOATS

Item	F CFA
Value Added by Animals Held in Herd:	
Males	1,076
Females	1,122
Total	2,198
Value Added by Surviving Young Born into Herd	4,176
Value of Milk Production	6,200
Cash Costs (Salt Purchases)	-250
TOTAL	12,324

TABLE 5

EXPECTED VALUE OF OUTPUT PER U.B.T. FROM THE COMBINED HERD OF CATTLE AND GOATS

Item		F CFA
Value Added by Cattle Held in the Herd		
Males	975	
Females	1,468	
Total		2,443
Value Added by Surviving Calves Born into the Herd		1,574
Value Added by Goats Held in the Herd		
Males	538	
Females	561	
Total		1,099
Value Added by Surviving Kids Born into the Herd		2,088
Value of Milk Production		9,450
Cash Costs (Salt Purchases)		-250
TOTAL		16,404

value of milk production. The low annual return to animals held is due to the risk parameters, as reflected in the survival probabilities. This suggests that improvements aimed at decreasing risk might have an important impact on the relative profitability of livestock production.

For either activity, milk production accounts for over half of the expected value of output net of cash costs. This reinforces the claims of sample households that milk was the most important output from livestock enterprises. It also suggests that technological improvements which affect milk production would have a greater impact on the relative profitability of livestock enterprises than would marketing interventions which affect the structure of animal prices. The effects of these and other policy initiatives will be examined using the linear programming model.

Consumption of Grain and Livestock Products.-- A summary of the estimated per capita consumption of the major grains and livestock products is provided in Table 6 . Calorie requirements are based on the age and sex composition of the average household in each subsample. As indicated, consumption of the two major grains fulfills more than half of the requirement for each subsample. Given the inability of the present distribution system to provide markets in the southern pastoral zone with a steady supply of high-quality grain, the importance of grain in the household diet is an additional incentive to continue grain cultivation.

The high proportion of calorie requirements derived from millet and sorghum consumption by Haussa households is somewhat disturbing. There are several possible explanations. First, the number of people consuming grain prepared by Haussa households may have been underestimated in that the presence of guests who visited the household only at mealtime was not recorded during the survey. Second, Haussa households may have consciously exaggerated grain consumption in the hope of obtaining additional food aid from government programs. Third, it could be that meat, milk, and sugar consumption were much [illegible] important sources of calories and protein among Tuareg households than among Haussa households. Tea and

TABLE 6

CONSUMPTION OF GRAIN AND LIVESTOCK PRODUCTS

	Estimated Daily Per Capita Consumption								
	Grain				Livestock Products				
Subsample	Millet (kg)	Sorghum (kg)	Total Caloric Value	Proportion of Requirement (%)	Meat (g.)	Milk (ml)	Total Caloric Value	Proportion of Requirement (%)	Total Contribution to Calorie Requirements (%)[a]
Haussa	.99	.26	2549	99	39	84	110	4	103
Village Tuareg	.44	.31	1482	58	21	213	181	7	65
Bush Tuareg	.28	.48	1450	51	13	351	272	10	61

[a] Proportion of calorie requirements derived from grain and livestock Products.

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sugar consumption probably provided most of the calories required by Tuareg households beyond those supplied by the consumption of grain and livestock products. Therefore, the high proportion of calories derived from grain consumption by Haussa households may indicate that such households had fewer and less important alternative sources of calories other than grain.

Livestock products definitely were a more important element of the household diet among Tuareg sample households than among households in the Haussa subsample. Bush Tuareg households in particular consumed an average of more than four times the daily per capita consumption of milk by Haussa households. On the other hand, Haussa households consumed an average of three times as much meat per capita as did Bush Tuareg households, but the quantity of meat consumed in general was quite small relative to milk consumpiton. This was particularly true of Tuareg households, which further corroborates the notion that animals that are held in Tuareg herds are kept primarily for their milk rather than for their meat.

Relative Ability of Production Systems Surveyed to Expand Cattle Production.-- As is apparent from the data presented in this section, there was a great deal of variation among households within each subsample. However, it is possible to generalize concerning the relative ability to expand cattle production. Of the three systems surveyed, those households classified as Bush Tuareg appear to have the greatest immediate interest in expanding self-managed herds. Relatively more of their income and food needs are derived from livestock production, in which all such households are currently engaged.

In contrast, Haussa households appear to be reluctant to rely on cattle, or livestock in general, as anything but a supplemental source of food and income, although they do see cattle as a preferred form of investment. However, even when acquired as an investment, Haussa households rarely manage the animals themselves and prefer instead to confide them to hired herders who do not live in the immediate vicinity of the household's abode.

Although Village Tuareg households may wish to join their Bush Tuareg neighbors tending cattle outside of the village, most households currently are unable to do so. They presently eke out an existence based on income derived from wage labor and small-scale retail trade, supplemented by grain produced on sub-marginal fields. Whenever some of their income can be set aside after fulfilling their immediate needs, they invest in small ruminants, but neither their small ruminant herds nor their other assets have expanded to the point where they could reasonably consider managing large ruminants such as cattle. The requisite initial investment, the time required to manage the cattle herd, and the risk involved currently are prohibitive for such households.

Thus, of the pastoral zone mixed farming systems which were considered by the survey, the Bush Tuareg system is the most likely to benefit directly from expanded cattle production. For this reason, as well as other reasons mentioned in this paper, the detailed analysis of alternative agricultural development policies is confined to the Bush Tuareg group.

Average Seasonal Labor Requirements of Bush Tuareg Agricultural Enterprises

This section describes the labor requirements of the six agricultural enterprises included in the linear programming analysis of the section which follows. These include: millet production, three sorghum production technologies with varying returns to land, goat production, and the production of goats combined with cattle.

Labor requirements are based on the average hours allocated to each by the groups of households defined below. For the four grain enterprises, labor requirements are measured in hours per hectare for each fortnight. To elaborate on the type of work undertaken within each fortnight, labor allocated to each grain production activity has been divided into five work categories: land preparation, planting, weeding, guarding the fields, and harvesting.

The average labor requirements for the two livestock enterprises are measured in hours per animal unit (U.B.T.). Once again, to illustrate the nature of the work, labor allocated to each of the two enterprises has been further divided into three work categories: pasture (grazing), watering, and milking.

As part of the linear programming analysis of the following section, it is assumed that labor requirements per hectare and per animal unit are fixed in each fortnight. This assumption is justified for the livestock production activities in that grazing, milking, and watering the animals must be carried out on a daily basis. It is also justified for the grain production activities,in that the timing of work associated with grain production is highly dependent on rainfall patterns. Thus, for a given temporal distribution of rainfall, labor requirements are fairly inflexible between fortnights.

Along the same lines, it is important to remember that the labor requirements specified below are strictly valid only for a given area in a given year. This is because changes in rainfall patterns over space and time would alter the labor requirements and the relative profitability of the various activities. Thus, the results given by the model described in the following section must be interpreted in light of rainfall patterns during the survey year. As indicated in the first section of this paper, rainfall patterns at the research site during the survey year were unusual because heavy rains fell late into the year, producing a second sorghum harvest, and there was a thirty-day drought during the early part of the growing season which crippled the millet crop.

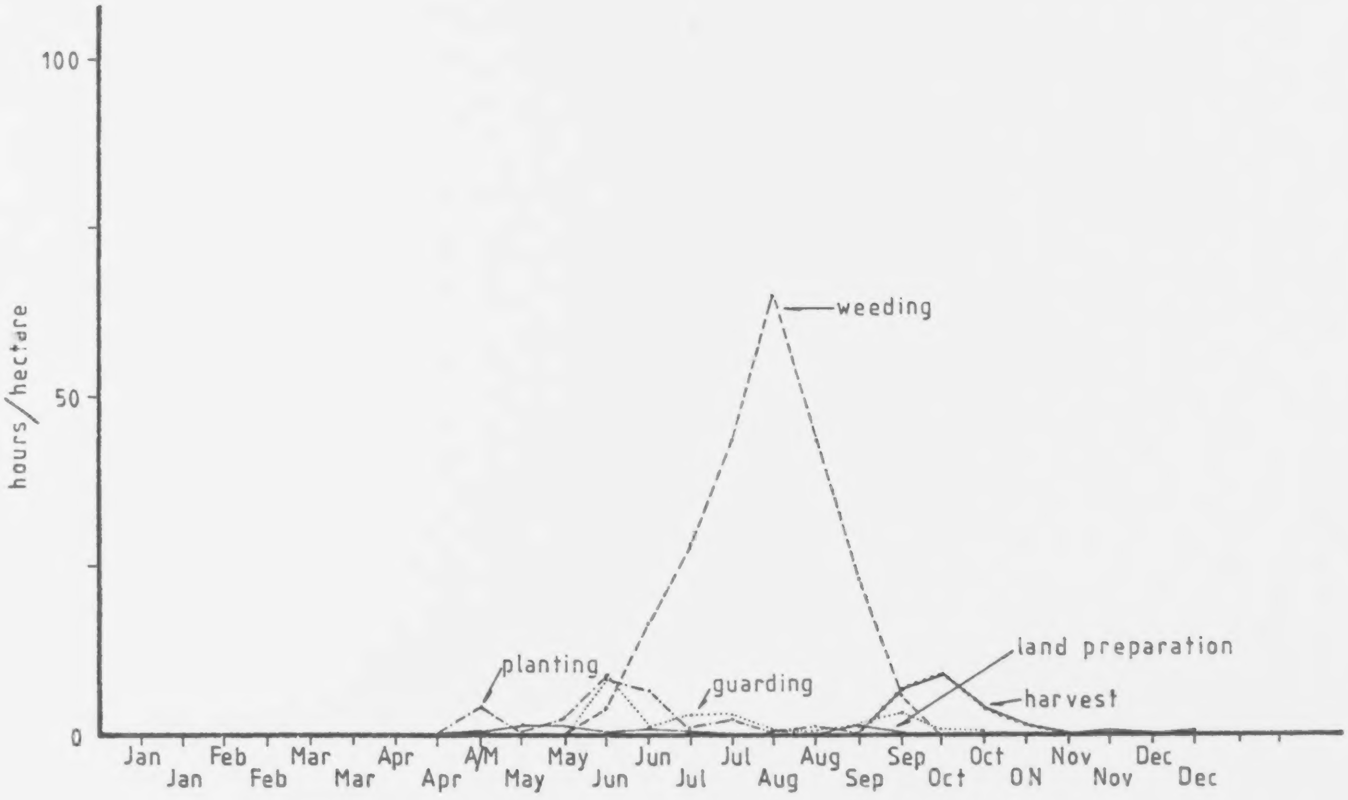
Millet.-- The labor requirements of the millet technology included in the model are based on the average hours per hectare devoted to millet by the households in the Haussa subsample. The Haussa millet technology was selected, since it was the most productive of the millet technologies observed among the three production systems. Since only one Bush Tuareg household was able to produce any millet at all during the survey year, the observed Bush Tuareg millet technology could not provide an adequate explanation of why Bush Tuareg households engaged in millet enterprises. Thus, the selection of the Haussa millet technology is predicated on the assumption that in making planting decisions for the coming crop cycle, Bush Tuareg households strive to emulate the best locally available technology for any particular enterprise. Indeed, this is the way in which sample members themselves characterized their decision-making: Tuareg households engaged in millet production under the assumption that they would be able to achieve the yeilds obtained by relatively more successful Haussa millet producers. For similar reasons, the most productive sorghum technologies have been selected for inclusion in the model, these being the technologies adopted by Bush Tuareg households during the survey year.

Average labor requirements for each work category in each fortnight are indicated in Figure 11 . As the graph suggests, labor inputs to millet production were concentrated in the June through October period, which is the rainy season. The major activity during that period was weeding, which was probably the most critical task and certainly the most demanding physically. Haussa households met the weeding labor requirement by hiring additional labor, particularly during August, the month of heaviest rainfall. The hiring of labor enabled Huassa producers to spend roughly equal amounts of time per hectare on weeding millet and sorghum fields during the critical period of heavy rainfall.

Discretionary income derived from sales of livestock and livestock products contributed to the ability to hire labor during this period. Hired labor accounted for one-third of the total labor allocated to weeding grain fields by the fourteen sample households which produced both large and small ruminants. In contrast, in seventeen sample households which had no animals, hired laborers contributed only 5 percent of total labor allocated to weeding. For some Tuareg households, the lack of discretionary income with which to hire labor forced them to choose between weeding millet or sorghum fields during the critical period of heavy rainfall. The resulting concentration of weeding labor on sorghum fields obviously contributed to the failure of the millet crop for these households.

Millet was grown mostly on upland, sandy soils for which very little preparation was required prior to planting. The first planting took place in early May, before the rains began. Fields were subsequently replanted as necessary during the early part of the rainy season.

FIGURE 11: Agricultural Calendar for Millet: Haussa Sub-sample



Guarding the millet fields, like land preparation, occupied relatively little time. Most of the labor allocated to guarding the fields was intended to protect the crop from herds in transit through the area. Thus, fields had to be guarded at the beginning and end of the rainy season when herds were in transit to and from northern pastures.

The harvest began in late September and continued through October. Since the herds of nomadic livestock producers were returning from northern pastures during this period, the ripened grain had to be evacuated rapidly to storage areas to avoid damage to the crop. Despite this time constraint, neither the harvesting activities nor any of the other three activities mentioned above constituted as large a proportion of the total labor requirement of the millet enterprise as did labor required for weeding during the rainy season.

Sorghum.-- The labor requirements of the three sorghum technologies included in the model are based on the average hours per hectare devoted to sorghum in each fortnight by each of three groups of households within the Bush Tuareg subsample. The three groups were distinguished on the basis of varying yields (averages of 350, 850 and 1,160 kg /ha). The average labor requirements, broken down by activity, for the two groups achieving greater per hectare yields are illustrated in Figures 12 and 13.

The most distinctive difference between the labor requirements for sorghum and those for millet is that sorghum is a much more labor-intensive enterprise, requiring a greater labor input per hectare for all five work categories. In particular, land preparation, planting, and guarding take on greater importance. Also, the harvest labor requirement during October and November is of comparable magnitude to the weeding labor requirement in July and August.

Significant amounts of land preparation are required for sorghum. Possibly as a result of the land preparation requirement, planting did not begin until late June, which was after the early rains. Additional plantings in late July were required to replace plants killed off in the thirty-day drought at the beginning of the rainy season.

FIGURE 12 : Labor Requirements by Activity for Average Yield Sorghum Technology

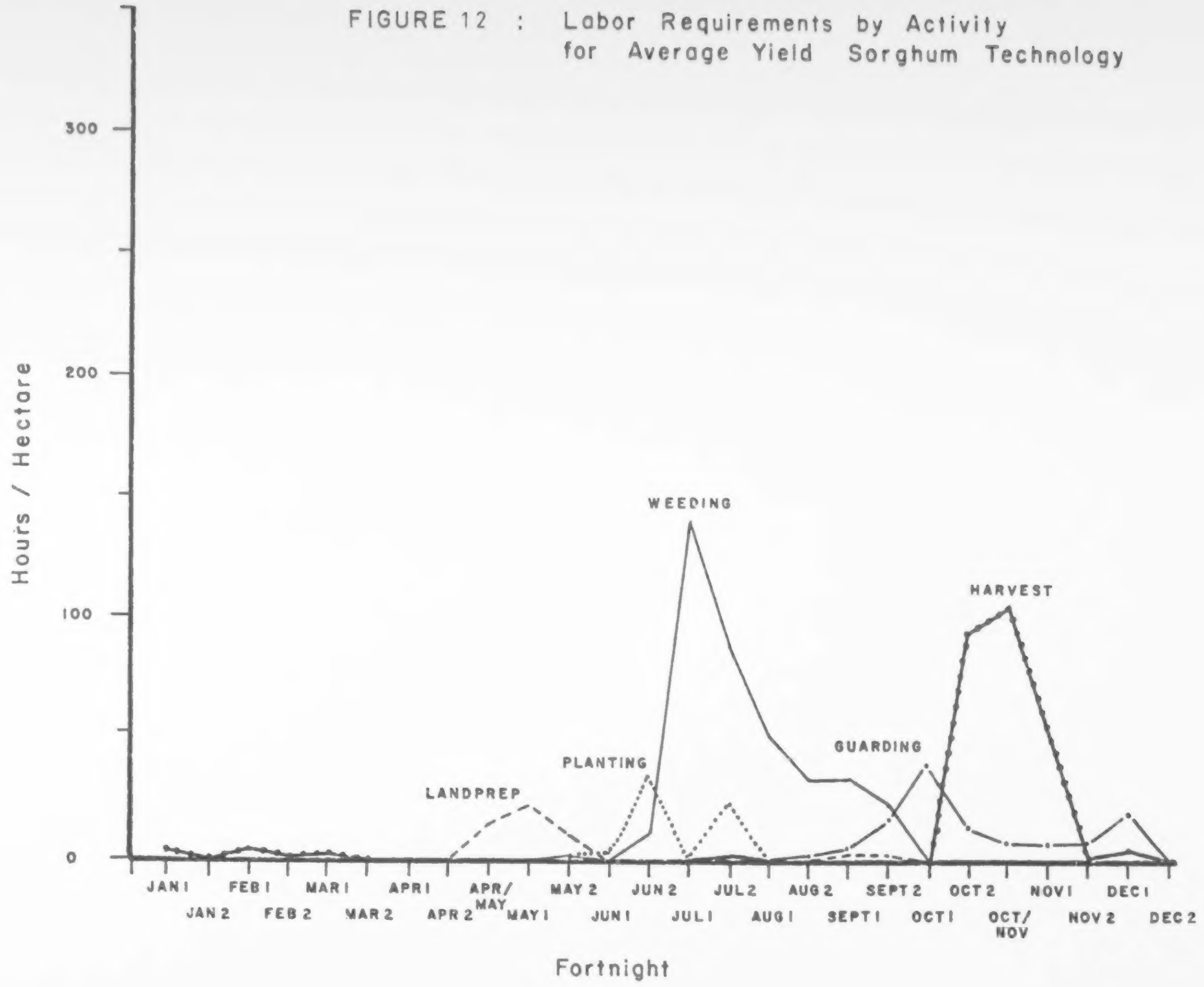
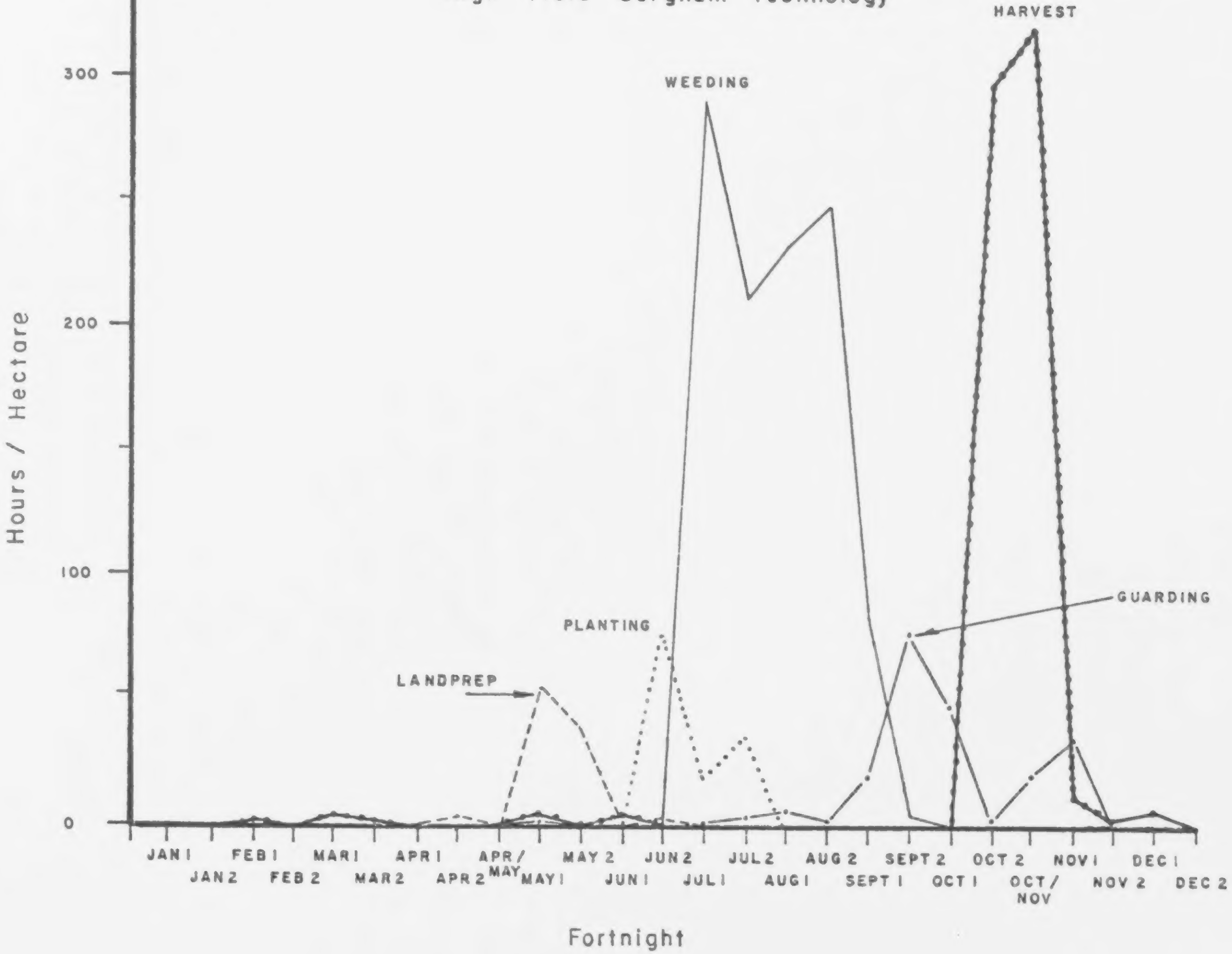


FIGURE 13 : Labor Requirements by Activity for High Yield Sorghum Technology



Unlike the Haussa millet technology, the peak requirement for labor allocated to weeding sorghum occurred in early July rather than August. A further difference is that the sorghum harvest began in earnest in late October, in contrast to the millet harvest, which commenced a month earlier. The later sorghum harvest meant that more labor had to be allocated to guarding the fields to prevent incursions by animals. The threat of trespassing animals was particularly acute at this time, since many animals were in transit through the area. Also, the heavy rains had stopped, and less pasture was available, making the ripening grain more attractive to transhumant herds. Finally, much of the pre-harvest labor in the grain fields had ceased, since the plants were already well established and the rains no longer made it necessary to continue intensive weeding. This meant that fewer people were regularly present in the grain fields, so there was a greater risk that animals would encroach upon unattended fields. As indicated by the timing of livestock labor requirements, the need to guard fields during this period may be an important constraint to agricultural production among mixed farmers.

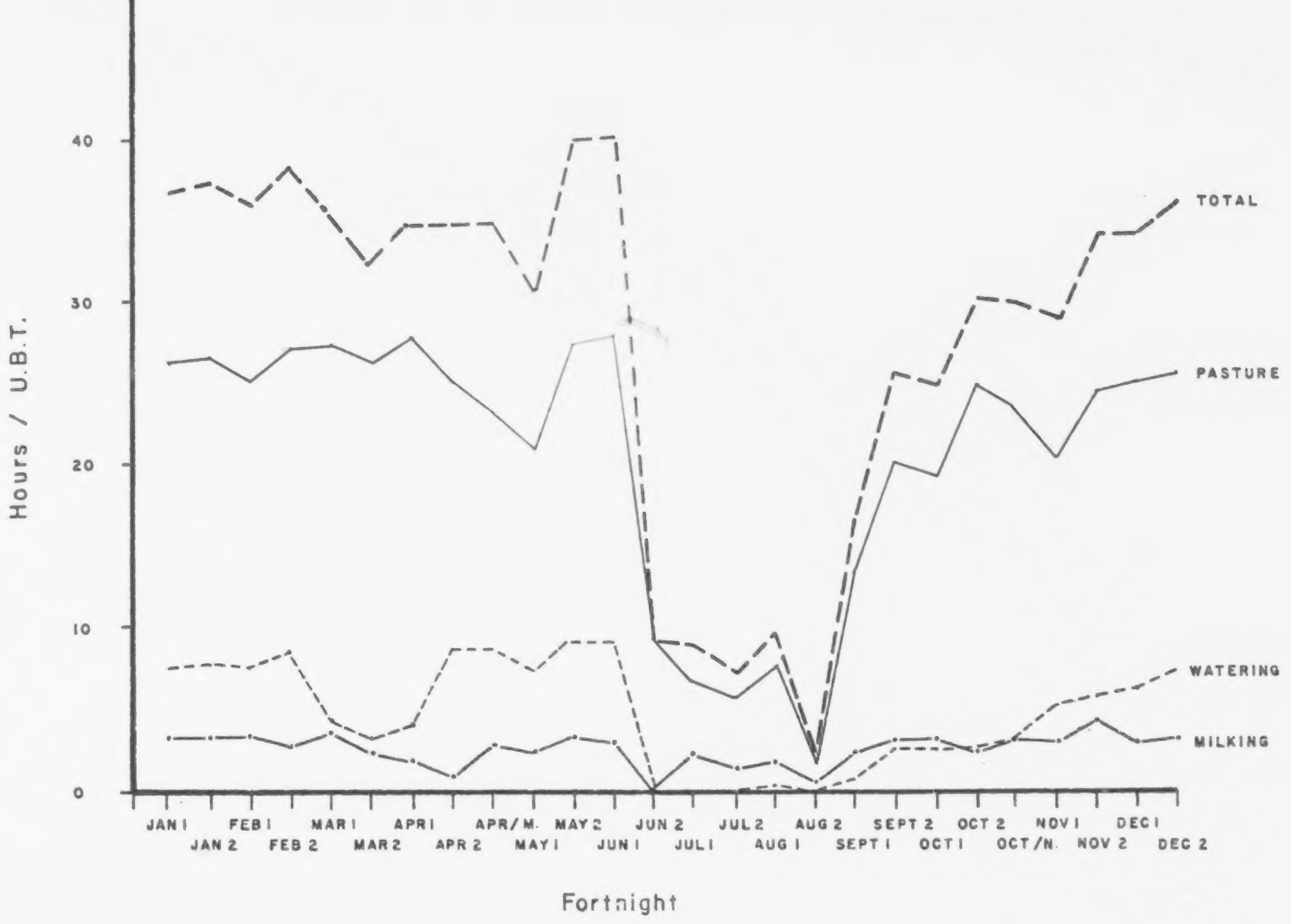
Goats.-- As indicated in the previous section, the livestock production options under consideration are limited to goats and cattle combined with goats, since these two types of herds were the most common among sample households. Furthermore, as indicated above in the subsection of livestock output, cattle were never raised independently of goats, since grain and livestock-producing households preferred to build up a subsistence herd of at least twenty goats before diversifying into cattle production. Before discussing the mixed herd option, the present subsection looks at the labor requirements of the basic goat herd, which contains twenty to twenty-five goats. As in the above discussion of livestock output, labor requirements for the goat herd and the mixed herd are given in terms of a standard unit (U.B.T.) which is equivalent to 5 goats or 1.2 head of cattle.

The breakdown of average labor requirements per animal unit for a sample of four Bush Tuareg goat herds is indicated in Figure 14. The most outstanding characteristic of the labor flows is the sharp drop in labor requirements from mid-June through August. This was the period during the rainy season when water and pasture were plentiful.

This was also the period when crops were in the ground and were developing. However, most crop producers were in their fields either planting or weeding at this time, so there was relatively little danger of animals wandering into the grain fields unobserved. Thus, during the height of the rainy season, the animals could be left to wander on their own in search of relatively abundant pasture and water, and more household labor could be devoted to grain production. For this reason, goat production labor requirements dropped to their annual low in late August when the combined requirements for weeding in both millet and sorghum fields were at an annual peak.

By September, the weeding of the grain crop was completed, and activities in the sorghum fields dropped off until the harvests began in October. As indicated above, the grain fields were vacant at this time (with the exception of those guarding the fields), and as the grain ripened, it became more attractive to the herds. As a result, the herds had to be placed under more regular surveillance to prevent them from entering the fields and damaging the grain crop. Thus, labor requirements rose sharply between August and September and increased more gradually throughout the harvest period as more labor was devoted to keeping the herds away from the ripening grain. At the same time, the amount of labor required for watering was increasing as surface water supplies dried up and herders had to begin watering their animals from the wells. The time required for milking also increased during this period since more animals in the herd were coming into milk. Thus, around the time of the grain harvest, sorghum and goat-producing households were faced simultaneously with rising demands for harvest labor and rising demands for labor allocated to all three major goat production activities. In contrast to the sharp dip during the rainy season, labor requirements were fairly stable throughout the cold season and hot dry season.

FIGURE 14 : Agricultural Calendar for an Average Goat Herd

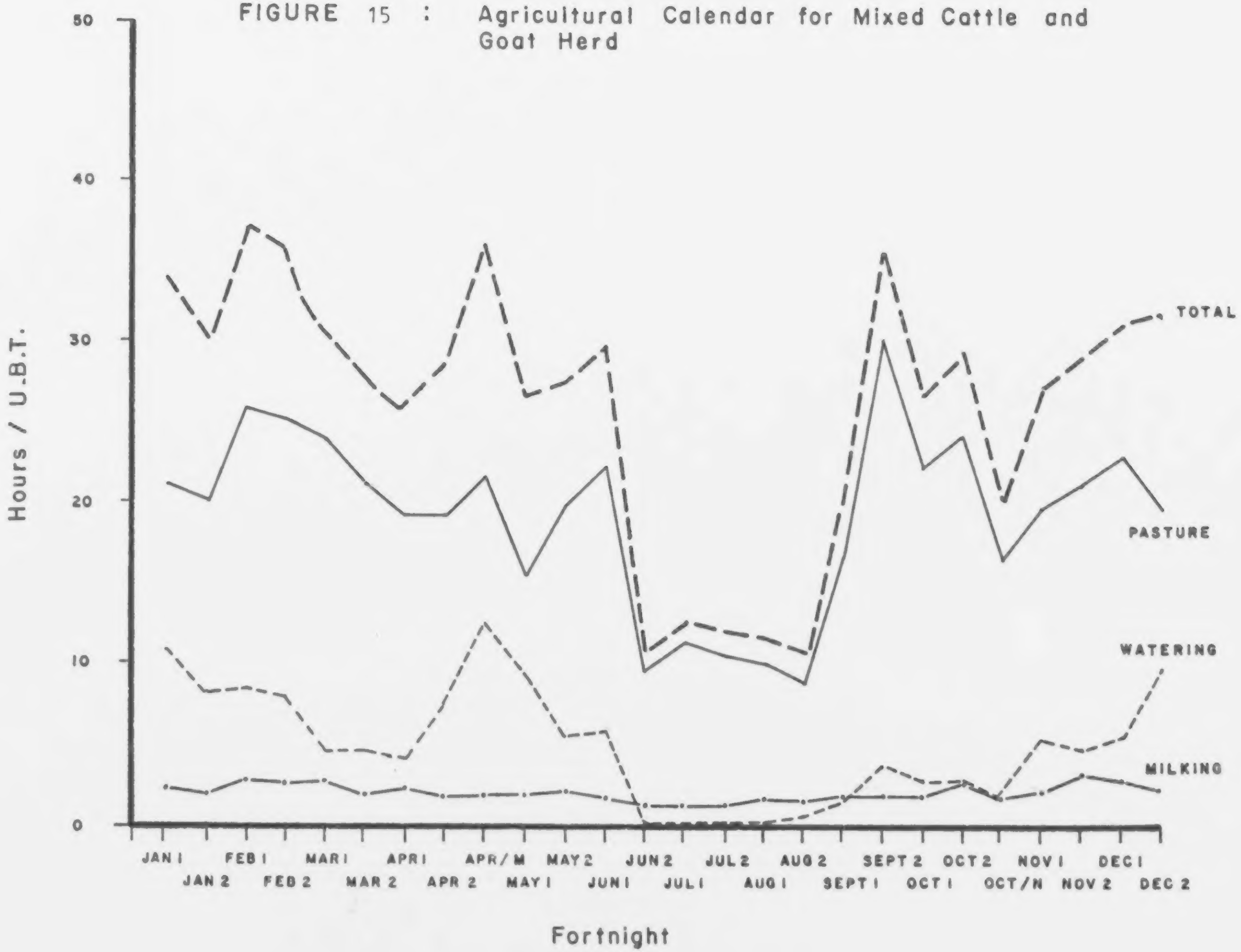


Mixed Herd of Cattle and Goats.-- Figure 15 illustrates the amount of labor required per animal unit and per fortnight to maintain a combined herd of twenty to twenty-five goats and three to five head of cattle. The overall pattern is very similar to that of the basic goat herd. In comparing the labor requirements per animal unit of the two types of herds, it does not appear that it is possible to realize any substantial economies of scale by expanding the basic goat herd to include cattle. Average labor requirements for both types of herds were similar in all but the June to August slack period.

The labor calendar for the mixed herd is marked by the same drop in labor requirements as that of the goat herd during the June to August period. However, average labor requirements per animal unit never dropped as low as those for the goat herd during this slack period. This probably was due to the fact that unattended cattle may do more damage to a grain field in a short period than goats. Therefore, cattle had to be watched more carefully than goats, even during the rainy season when water and pasture were more plentiful. Thus, the rainy season labor requirements for the mixed herd did not appear to be as flexible as those fo the goat herd.

This relative inflexibility of labor requirements applied equally well to the month of September, the time at the beginning of the grain harvest when labor requirements for the mixed herd rose to one of three annual peaks. During this time, the cattle had to be watched closely, since they in particular were attracted to the ripening heads of grain at a time when the grass cover which they relied on for feed was beginning to be depleted. The goats could still browse from trees and shrubs at this time, but the cattle did not have this option and were thus more attracted to the ripening grain. The following section examines the extent to which these differences in labor requirements interfere with the expansion of cattle production.

FIGURE 15 : Agricultural Calendar for Mixed Cattle and Goat Herd



Analysis of Bush Tuareg Agricultural Production

In this section, the information presented thus far is incorporated into a linear programming model of a Bush Tuareg mixed farm whose production possibilities are millet, sorghum, goats and cattle. The model is exploited to simulate the effects of three policy options intended to promote specialization in cattle production: (1) government distribution programs which grant or loan animals to livestock producers; (2) grain market interventions which would alter the price and quantity supplied of grain to the local market; and (3) the introduction of new technologies which would increase the milk yields of cows and goats. A critique of the results obtained and alternative policy recommendations follow in the final section of the paper. Briefly, the factors which appear to restrict Bush Tuareg cattle production and limit the efficacy of the above policies are: (1) seasonal labor bottlenecks at the beginning and end of the growing season; (2) the desire on the part of Bush Tuareg mixed farmers to be self-sufficient in grain; and (3) the importance of the goat as a relatively risk-free source of milk, meat, and cash income.

The Model.-- The basic model is a conventional farm management model which allows for selection among millet, sorghum, goat and cattle production activities subject to labor, land and subsistence constraints. The primal problem could be described as follows: with a given unit of value of each of the outputs (c_i) and a given upper limit for the availability of the labor input in each fortnight (b_j) and of the total land input to sorghum enterprises (1_s) what is the size of each activity (X_i), as measured in units of land and livestock, which would maximize the net value of the total output? The model can be expressed algebraically as:

$$Y = \text{MAX} \sum_{i=1}^{6} c_i X_i$$

subject to:

$$\sum_{i=1}^{6} a_{ij} X_i \leqq b_j \qquad (j = 1, \ldots, 26)$$

$$\sum_{i=2}^{4} X_i \leqq 1_s$$

where: Y = maximum value of output, net of seed, salt, and other purchased inputs

X_1 = millet activity (measured in hectares)

X_2 = low-yielding sorghum activity (in hectares)

X_3 = medium-yielding sorghum activity (in hectares)

X_4 = high-yielding sorghum activity (in hectares)

X_5 = goat activity (in U.B.T.)

X_6 = mixed cattle and goat activity (in U.B.T.)

i,j = subscripts indicating activity and time (fortnight), respectively

c_i = net value of output from one unit of the i^{th} activity

a_{ij} = hours of labor required per unit of the i^{th} activity in the j^{th} fortnight in order to attain the yields implicit in the c_i.

b_j = total hours of labor available for agricultural activities in the j^{th} fortnight

l_s = total hectares of land suitable for sorghum production (lowlands) which the household may expect to obtain.

The model offers as options six activities (enterprises), four of which are related to grain production and two to livestock. The four grain enterprises are measured in terms of the land input in hectares. Three of the grain enterprises involve sorghum production with three different per-hectare yields. The fourth is a millet enterprise based on the Haussa millet technology, as described in the previous section. It is assumed that millet and sorghum enterprises are distinct in that millet cultivation is confined to upland, predominantly sandy soils, and sorghum cultivation is likewise restricted to lowland alluvial soils. This was true for all households in the Bush Tuareg subsample.

The livestock enterprises consist either of goats alone or goats combined with cattle. Each of the livestock enterprises is measured in terms of U.B.T. equivalents (1 U.B.T. = 5 goats = 1.2 head of cattle). Cattle production is not an independent enterprise in the model, since, as previously indicated, all sample households which produced cattle also produced goats, and the labor inputs to the production of one animal type were inseparable from inputs to the production of the other. Therefore, combined goat and cattle production is considered to be one enterprise.

For the purposes of the combined livestock enterprise, it is assumed that there are equal numbers of U.B.T. equivalents of each animal type in the herd. Thus, each unit of the model goat/cattle enterprise contains the equivalent of 2.5 head of goats and 0.6 head of cattle. Each unit of the goat enterprise contains five head of goats. This conforms with the herd compositions assumed above in the calculation of the returns to and the average labor requirements for the respective enterprises.

In incorporating several sorghum technologies and two livestock enterprises, the model does allow for some flexibility in input (labor/land) ratios and herd composition. One potential problem with this formulation, however, is that it assumes that goats will always be combined with cattle in a proportion of at least four head of goats to one head of cattle (2.5 to 0.6). It is doubtful that this poses any great difficulty, since sample members actually did combine goats with cattle in at least that proportion. Furthermore, in the following analysis, whenever the combined livestock enterprise entered the optimal solution, additional units of the goat enterprise usually were selected along with the optimal number of units of the combined goat/cattle enterprise, indicating that the optimal enterprise combination usually involved combining goats with cattle in a ratio greater than 4-to-1. It should be borne in mind, however, that the model does not allow for a combination of goats and cattle in less than a 4-to-1 ratio.

Fixed labor requirements per hectare and per animal unit for each enterprise in each fortnight are derived from the material presented in the previous section. Labor requirements are specified for each enterprise in each fortnight in order to identify as precisely as possible the seasonal labor bottlenecks which constrain agricultural output. Since labor requirements are based on the average observed values within each group of households, the present model is limited to an approximation of the "average" Bush Tuareg household. The behavior of households which deviate in various respects from this overall "average" is simulated by adjusting the labor constraints to reflect the characteristics of larger households, as described below.

Value coefficients for the grain enterprises are the actual average net returns per hectare for the relevant group of households, as described in the previous section. These coefficients and the physical yields and prices on which they are based are listed in Table 7. Physical yields are net of seed requirements for the following year.

TABLE 7

GRAIN PRODUCTION STATISTICS AND VALUE COEFFICIENTS FOR MODEL GRAIN TECHNOLOGIES

	Millet	Sorghum		
Statistic:		Low-Yield	Medium-Yield	High-Yield
Hours/Ha	305.	530.	1,070.	2,157.
Kg /Ha	46.	300.	850.	1,160.
Kg /Hour	.15	.57	.79	.54
Value:				
Price (CFA/Kg)	68.	61.	61.	61.
CFA/Ha	3,128.	18,300.	51,850.	70,760.
CFA/Hour	10.20	34.77	48.19	32.94

The prices are the means of the weekly price observations recorded during the commodity price surveys conducted by the research team. The mean of the weekly observations, rather than an expected value based on grain sales patterns, was selected as the most representative price at which to evaluate grain output, since on the average, less than one-fourth of total grain production was marketed by Bush Tuareg households during the survey year. A sensitivity analysis of grain prices in the model is included in the following discussion.

The value coefficients for the two livestock enterprises are the measures of livestock output which were derived in the subsection covering that topic. Thus, the coefficients express the value of milk production, the appreciation in value of animals held in the herd (discounted for risk), and the value of surviving animals born into the herd. These coefficients are designed to estimate the return to one year's labor input which can be expected from one animal unit (one U.B.T.).

The returns to labor and livestock implicit in these coefficients are summarized in Table 8. The following analysis includes a sensitivity analysis of these coefficients, based on assumed increases in milk yields beyond the levels observed during the survey year. Since the value of milk output accounted for more than half of the total estimated returns to livestock enterprises, the sensitivity analysis concentrates on that portion of the value of livestock production.

TABLE 8

ANNUAL RETURNS TO LABOR AND LIVESTOCK FROM
MODEL LIVESTOCK ACTIVITIES

Statistic	Activity	
	Goats	Goats and Cattle
Hours/U.B.T.	734.	682.
CFA/U.B.T.	12,324.	16,405.
CFA/Hour	16.79	24.05

Labor constraints are formulated under the assumption that household members would prefer not to spend less time on commerce and domestic activities than that amount of time actually allocated to those activities during the survey year. Furthermore, it is assumed that each household member requires a minimum of three hours of rest during the twelve daylight hours of each day, including the amount of time spent at meals. Thus, the minimum rest requirement for each individual present in the household and the amount of time actually spent on commerce and domestic activities in each fortnight are deducted from the total amount of labor available,to arrive at an estimate of the maximum amount of labor available for agricultural enterprises in each fortnight for each household. These figures are then averaged over a given set of households to derive the labor constraints.

Two sets of households and the resulting two sets of labor constraints are considered in the following analysis. The first set consists of Bush Tuareg goat-producing households which were of average size relative to the entire set of households in the Bush Tuareg subsample. These will be referred to subsequently as the average Bush Tuareg households. Since cattle production was confined to households of above average size, the second set of households for which labor constraints are formulated consists of the larger Bush Tuareg households which produced both large and small ruminants. In the following discussion, these households will be referred to as the large Bush Tuareg households.

A land constraint is included to ensure that optimal solutions do not involve unrealistic land use plans. The land constraint affects only sorghum enterprises, since land suitable for millet production did not appear to be a scarce factor in the survey area. Thus, the constraint applies to those lowland, alluvial, primarily clay soils which were planted predominantly to sorghum.

The land constraint to sorghum enterprises was set at 5.00 hectares. This is the quantity of land suitable for sorghum production which Bush Tuareg households could reasonably expect to obtain. The constraint was never binding in any of the situations considered, suggesting that the availability of labor rather than the availability of land is what limits agricultural production on mixed farms in the southern pastoral zone.

In qualitative interviews, Bush Tuareg households indicated that given the choice between grain and livestock enterprises, they would prefer to assure subsistence needs in grain before engaging in livestock enterprises. To reflect this, a subsistence constraint was incorporated in the model, and solutions to the primal problem were examined with and without this constraint. To formulate the constraint, the minimum grain requirement per working household member was assumed to be the mean observed annual consumption of grain by households in the Bush Tuareg subsample. Thus, the subsistence constraint implies that the physical output of grain from the four grain activities must be greater than or equal to the observed consumption of grain for a set of households of a given size.

With the subsistence constraint introduced into the model, a parametric analysis of labor availability was conducted for households of various initial sizes. The results indicated that household size and labor availability are important determinants of enterprise combination. Specifically, the results suggested that, given the preferences and value-maximizing behavior outlined above, the ability to engage in cattle production while ensuring subsistence food needs is restricted to households of above average size. This would explain why only 30 percent of the sample households, all of which were of above average size, were engaged in the production of large ruminants at some point during the survey year.

Furthermore, it appeared that subsistence constraints were binding only for those households of average or below average size. The minimum grain production requirement imposed by the subsistence constraint did not alter the optimal solution to the value maximization problem for the relatively large households. However, subsistence constraints were binding for smaller households and did effectively eliminate the possibility of cattle production by such households. Unless otherwise indicated, the subsistence constraint is not incorporated in the model for the purpose of the following analyses. However, separate consideration is given to the extent to which the solutions thus derived will fulfill grain consumption requirements.

The following analysis applies directly to a cross-section of Bush Tuareg households in a year in which, in addition to the other parameters in the model, the amount and distribution of rainfall was as observed during the survey year. This latter consideration is particularly important, since varying amounts and spatial and temporal patterns of rainfall would alter the labor requirements and possibly the relative profitability of agricultural enterprises. Thus, the results of the analysis, with the parameters as given, are useful for cross-sectional comparisons, but given the extensive variability of rainfall patterns in the southern pastoral zone, these results could not be used reliably to predict or explain behavior over time or between regions.

Simulated Effect of Increasing Herd Size. -- To simulate the effect of development programs whose aim is to distribute additional animals to livestock producers, a parametric analysis of herd size is conducted by setting the levels of one or both of the livestock enterprises to zero and then forcing increases in herd size by one animal unit at a time. The effect of the increases in herd size on the optimal levels of the other enterprises and on the total value of output is then examined. The analysis discloses that producers are currently maintaining herds which are of optimal or near-optimal size and that grants of additional animals, without complementary interventions to relieve currently binding constraints, would actually force a reduction in the total value of output.

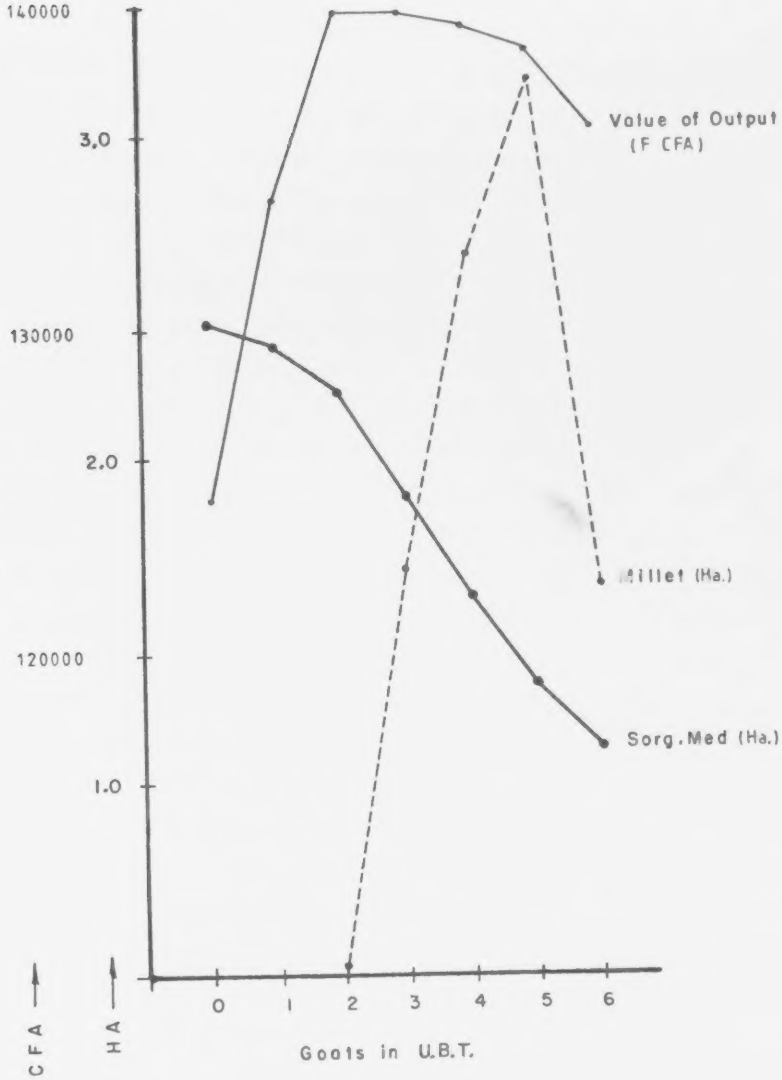
The underlying rationale for animal distribution programs is that producers are not currently managing more animals simply because they cannot afford to acquire them. The logical extension of this is that the provision of credit or outright grants of animals would enable producers to expand their herds to their optimal size. However, since the following analysis discloses that producers are currently maintaining herds of optimal size, it then becomes relevant to ask what constraints limit the expansion of those herds and what complementary policy initiatives would relax such constraints. These are the subjects covered in the remainder of this paper.

The first portion of this section is concerned with the ability of the average Bush Tuareg household to expand goat production beyond current levels. The households in question currently maintain herds of approximately twenty goats, but no cattle. Since Tuareg households indicated that they were reluctant to engage in cattle production unless they could simultaneously maintain a subsistence herd of a least twenty goats, the following examines the effect of increasing the average household's goat herd beyond twenty head, or 4 U.B.T. Since the average Bush Tuareg household did not engage in cattle production, the combined cattle and goat production activity is excluded from the model when such households are the subject of the analysis. The specific issue investigated below is whether households of average size are operating their goat enterprises at optimal levels and, if so, what restricts the goat enterprise to a level at which such households are reluctant to take on the risk of incorporating cattle in their herds.

The results of the parametric analysis of goat herd size for average Bush Tuareg households are summarized in Figure 16. Given the model as stated above, maximum value of output for these households is attained at a goat herd size equivalent to 2 U.B.T., or 10 goats. Up to this point, the net value of output rises rapidly as goats are forced into the solution. Between this point and the point that coincides with current production levels (4 U.B.T., or 20 goats), the value of output declines gradually as goats are added. Beyond 4 U.B.T., the value of the objective function declines more rapidly. When a herd of 35 goats, or 7 U.B.T., is forced in, the solution becomes infeasible, given the labor constraints applicable to this set of households during the survey year. The solution given by the model with the goat herd size set at 20 head (4 U.B.T.) is quite close to the average enterprise size and combination observed among the relevant set of households.

As goats are added initially, the level of sorghum production in the optimal plan decreases, and millet production is substituted for some of the sorghum. Combining millet and sorghum production can be seen as a means of minimizing risk since the success of one or the other crop could not be known in advance due to uncertainty concerning rainfall. The millet

FIGURE 16 : Substitution Relationship Between Grain and Livestock Production with Varying Goat Herd Size: Average Bush Tuareg Household



crop is relatively more successful in years of higher rainfall, and the sorghum fields, being in low-lying areas which receive water from the surrounding hills, provide some grain even in years of abnormally low rainfall. Thus, the combination of grain enterprises ensures some millet output in years in which rainfall is abnormally high and the sorghum crop is drowned out, or a steady supply of grain from lowland sorghum fields in years such as the survey year, when rainfall is below average. The desire to produce both millet and sorghum in order to minimize the risk of total crop failure due to uncertain rainfall assists in explaining why Bush Tuareg households of average size were found to engage in goat enterprises at a scale beyond that which would appear to be optimal. Rather than maximizing the value of output by producing fewer goats, more sorghum, and no millet, producers may prefer to sacrifice some sorghum production in years of low rainfall in order to produce both millet and sorghum and more goats.

At a goat herd size of up to ten head and the optimal levels of millet and sorghum production associated with that herd size, output is constrained by labor availability in early July. However, when additional units of goats are forced into the solution, the most critical period of labor scarcity is late October. As explained above, the labor constraint in this period is due to the need to prevent the animals from consuming the ripened grain which is still in the fields and the need to evacuate the newly ripened grain to secure storage facilities.

The above analysis illuminates several important points. The first and probably most important point is that for the average Bush Tuareg household, there exists an optimal (or near-optimal) herd size of between 2 and 4 U.B.T. of goats (ten to twenty head), and that barring changes in technology, relative prices, or labor availability, the total value of output is drastically reduced when attempts are made to increase herd size beyond this optimal range. The second is that the desire to avoid risk by combining millet and sorghum production may force the producer to select a slightly sub-optimal enterprise combination. The third point is that within the range of enterprise combinations actually selected by this set of households during the survey year, the model indicates that the most critical period of labor scarcity is during the harvest period in late October. These results suggest that in the situation witnessed by the research team, additional grants of animals, in the absence of complementary policy initiatives, would not enable the average-size household to expand livestock production without seriously affecting grain output and the total value of production from agricultural enterprises.

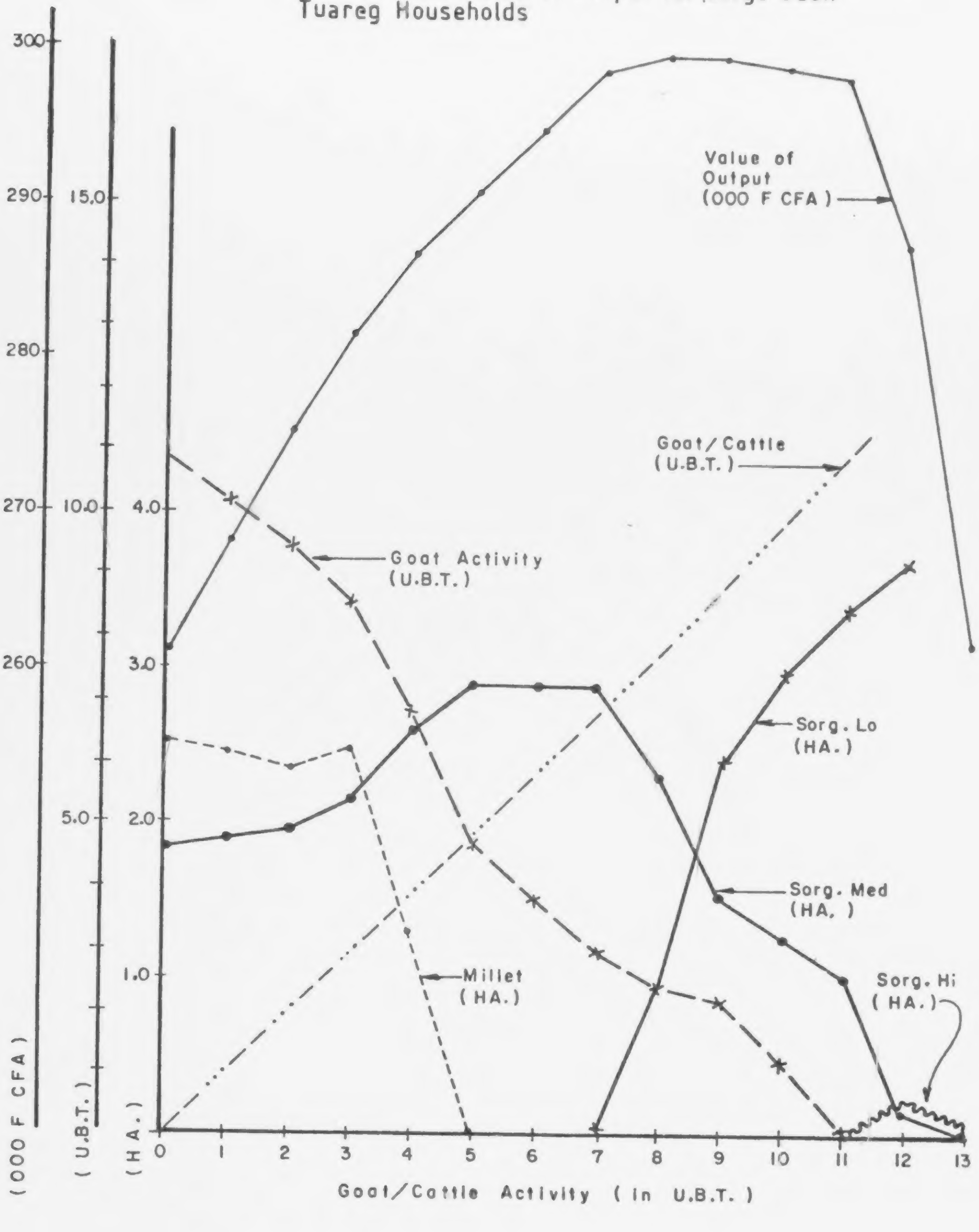
The second portion of this section is concerned with that set of Tuareg households which are large enough to keep both large and small ruminants while producing enough grain to satisfy the household's consumption needs. Cattle production by Tuareg mixed farmers was restricted to households of this size. Since it is found that these larger households also are operating at optimal levels for each enterprise, the analysis of this subsection also attempts to identify the factors which limit the effectiveness of animal distribution programs by restricting the expansion of cattle production.

The analysis centers around a set of parametric programming results which use the labor constraints applicable to large Bush Tuareg households. To obtain these results, the combined cattle and goat production activity was forced into the solution in increments of one animal unit (U.B.T.) up to the point where the introduction of additional goat/cattle units forced a sharp decline in the total value of output. The results of this exercise are illustrated in Figure 17. Each unit of the goat/cattle activity is assumed to contain equal proportions of U.B.T. equivalents of goats and cattle, or 2.5 goats combined with 0.6 head of cattle. Thus, with each increase of one unit of the goat/cattle activity, an additional 0.6 head of cattle are forced into the solution.

The analysis suggests that the value of output is maximized at a level of the goat/cattle activity which is close to 8 U.B.T., or five head of cattle. Furthermore, as other activities are allowed to adjust to optimal levels, the value of output is relatively insensitive to variations in the level of the goat/cattle activity between 7 and 11 U.B.T., which corresponds to four to seven head of cattle. This range and the optimal plans within it coincide with the range of enterprise sizes and combinations actually managed by Tuareg households of comparable size. The value of output declines abruptly when the goat/cattle activity is forced to levels outside of this range.

Based on Figure 17, the effects of the introduction of cattle into the herds of large Bush Tuareg households can be separated into four stages. The first stage is marked by a cattle herd of less than two head and a com-

FIGURE 17: Effect of Expanding Goat/Cattle Herds on Land Use and Total Value of Output for Large Bush Tuareg Households



plementary optimal plan consisting of millet, goats, and medium-yield sorghum. The second stage is associated with a cattle herd of between two and four head, or 3 to 7 U.B.T. of the goat/cattle activity. Within this range, as the cattle herd is increased, the millet activity is forced out of the solution, and the optimal size of the goat herd diminishes.

The third stage is associated with a cattle herd of between four and seven head (7 to 10 U.B.T.). In this range, as indicated above, the maximum value of output is attained, and the maximand is relatively insensitive to changes in herd composition. As the size of the cattle herd is increased within this range, the optimal size of the goat herd remains relatively stable, but labor constraints during the early harvest period force the substitution of the less labor-intensive sorghum technology for the medium-yield technology. This switch to the less labor-intensive grain technology would assist in explaining why some surveys indicate that cattle-producing households achieve lower per-hectare grain yields than similar households not producing cattle. Finally, in the fourth stage, as the size of the cattle herd increases beyond seven head, the total value of output and the size of all grain enterprises declines abruptly.

As cattle are introduced in the first two stages of the above sequence, agricultural output is limited by labor scarcity in late October. However, in the third stage, as the size of the cattle herd is increased beyond five head, the scarcity of labor in late September becomes a more important restriction on the expansion of agricultural output than the late October labor constraint. As explained in the previous section, this is because the larger cattle herds require more care at the beginning of the grain harvest, when they must be kept away from the ripened grain which is still standing in the fields. This suggests that efforts to expand cattle production among large Bush Tuareg households should be accompanied by some means of alleviating the September labor constraint.

This section has concentrated on using the model to derive the optimal enterprise mix associated with each stage of expansion of the livestock herd. The analysis has focused on Bush Tuareg households of either average or above average size. The results suggest that the average Bush Tuareg household is limited to a livestock herd consisting of no more than twenty head of goats. The results also suggest that even the largest Bush Tuareg households are limited to a herd of thirty goats and, at most, seven head of cattle. As herds are expanded beyond these optimal levels, labor constraints force a sharp reduction in the total value of output and in total grain production. This indicates that animal distribution programs alone are unlikely to be effective in increasing cattle production on Bush Tuareg mixed farms.

The simulation shows that if the opportunity to produce livestock were eliminated, the value-maximizing model household would select an average-yield (850 kg /ha) sorghum enterprise. As goats and then cattle are forced into the solution, the model household shifts to less productive grain enterprises such as millet (46 kg /ha) and the less labor-intensive sorghum enterprise (300 kg /ha). The net value of total output initially rises, and total grain production initially declines. As herds are expanded beyond the levels stated above, however, and the size of grain enterprises is allowed to adjust to optimal levels, both the value of total output and total grain production decrease rapidly.

Since similar sample households are now producing at or near the optimal levels of the livestock enterprises indicated by the parametric analysis, it then becomes relevant to identify the binding labor constraints and suggest means of alleviating those constraints. In the case of the average Bush Tuareg household, labor availability becomes a binding constraint to the expansion of agricultural enterprises in late October at the time of the grain harvest. This constraint also effectively prevents the household of average size from engaging in cattle production, given the following set of preferences: 1) the desire to produce enough grain to fulfill the household's subsistence needs; 2) the desire to diversify grain production to avoid the risk of crop failure in years of abnormal rainfall; and 3) the desire to acquire and maintain a herd of at least twenty goats before engaging in the more risky cattle enterprise.

Although the larger households in the sample were able to meet the above requirements and still engage in cattle production, labor constraints for the large model households still restricted optimal enterprise size and combination to no more than thirty goats and seven head of cattle. At near-optimal herd sizes, the analysis indicated that labor constraints for such households are binding in early July and late September. The former constraint occurs during the peak period of weeding activity in the sorghum fields. The latter comes during the pre-harvest period following the completion of weeding when animals must be kept away from the ripening grain.

Policy initiatives which may assist in alleviating the constraints identified above will be discussed later in the chapter. Prior to that, however, the following section uses the model to examine a different approach to the problem of increasing cattle production among Bush Tuareg mixed farmers.

Simulated Effect of Decreasing Grain Prices. -- This section uses the model to simulate the effects of marketing interventions on optimal enterprise size and combination. The interventions in question are those which would lower grain prices at the local market, thus raising the relative profitability of livestock production. To conduct the simulation, the grain prices used to calculate the value coefficients of millet and sorghum enterprises were lowered by as much as 50 percent of their original levels while holding all other parameters constant.

As in the previous section, the analysis is restricted to Bush Tuareg households of average or above average size. Once again, the primary reason for this choice is that when compared to other sample households, these households appear to have the greatest potential for entering into or increasing cattle production in the near future. More importantly, from among the three production systems surveyed, Bush Tuareg households are probably the most representative of the majority of crop and livestock-producing households in Niger's southern pastoral zone.

To conduct the sensitivity analysis of grain prices, prices were reduced in 5 F/kg increments from the average retail prices for grain used in the previous section (68 F/kg for millet and 61 F/kg for sorghum). Solutions to the value-maximization problem were obtained after each incremental change in the coefficients as a result of the changes in grain prices. The results of such an analysis as applied to the average Bush Tuareg model household are shown in Table 9.

The analysis indicates that solutions to the value-maximization problem are initially quite sensitive to changes in the coefficients. The optimal size of the goat herd increases from eight head (1.66 U.B.T.) to approximately twenty-five head (5.07 U.B.T.) after a decrease in grain prices of only 7 percent (5 F/kg). A decrease in grain prices of 15 F/kg, or approximately one-fourth of the original price, further increases the optimal size of the goat herd to thirty-three head (6.58 U.B.T.).

TABLE 9

EFFECT OF DECREASING GRAIN PRICES ON LAND USE, GOAT HERD SIZE, AND THE NET VALUE OF OUTPUT FOR THE AVERAGE BUSH TUAREG HOUSEHOLD

Change in Grain Prices (CFA F/kg)	Crops (in Ha)		Goats[a] (UBT)	Net Value of Output (CFA F)
	Millet	Sorghum (average yield)		
0		2.31	1.66	140,034.
- 5	3.21	1.28	5.07	132,567.
- 10	3.21	1.28	5.07	126,397.
- 15	.58	1.00	6.58	121,510.
- 20	.58	1.00	6.58	117,142.
- 25	.58	1.00	6.58	112,774.
- 30	.58	1.00	6.58	108,406.

[a] The combined goat/cattle enterprise was eliminated from the model for the purposes of this analysis.

Presumably, such a decrease in grain prices would raise the optimal size of the goat herd to the point where the average household could reasonably consider the introduction of the cattle enterprise, knowing that they could rely on their larger goat herd to offset the risks entailed in the new enterprise. In other words, the decrease in grain prices would make it profitable to acquire a goat herd sufficiently large for the household to consider expanding into cattle production. Furthermore, if the drop in prices would induce the household to rely on the local market as a source of subsistence grain, then the subsistence constraint on grain production would no longer be relevant. The final result would be that the average household could engage in cattle production without fear of the risks involved in that enterprise nor of the risk of falling short of subsistence needs in grain as long as the market provided high-quality grain at the reduced prices indicated.

The results of a similar analysis as applied to the larger Bush Tuareg households are listed in Table 10 . The results obtained are comparable to those discussed above for the average household. With a 7 percent decrease in grain prices, the optimal herd size and composition changes from thirty-two goats and four or five head of cattle to thirty-four goats and six head of cattle. A further drop in grain prices down to 85 percent of the original level would cause a shift in the herd composition towards cattle so that the optimal herd becomes one of twenty-eight goats and seven head of cattle. This solution remains fairly stable throughout the further reductions in grain prices indicated in Table 10. The stability of the solution in this range may be deceptive, however, since the model does not allow for complete specialization in livestock. Were such an alternative to be included in the model, it is conceivable that the optimal size of the cattle herd would continue to increase as grain prices are reduced by amounts greater than 10 CFA F/kg below original levels.

Despite the shift towards livestock production induced by the fall in grain prices, the above analyses suggest that at least for small changes, more land would be put into grain production as grain prices decline. This is a result of the shift to more land-extensive grain production technologies as the size of livestock enterprises increases. A similar shift was noted in the analysis described in the previous section.

TABLE 10

EFFECT OF DECREASING GRAIN PRICES ON LAND USE, HERD SIZE, AND THE NET VALUE OF OUTPUT FOR THE LARGE BUSH TUAREG HOUSEHOLD

Change in Grain Prices (CFA F/kg.)	Sorghum[a] (Ha.)			Livestock (UBT)		Net Value of Output (CFA F)
	Low Yield	Average Yield	High Yield	Goat Enterprise	Combined Goat/Cattle	
0		2.82		2.67	7.33	299,696.
- 5	2.61	1.45		2.15	9.14	289,106.
- 10	3.45	1.00			11.16	279,090.
- 15	3.45	1.00			11.16	269,679.
- 20	3.45	1.00			11.16	260,268.
- 25	3.67	.52	.17		11.50	251,226.
- 30	3.69		.25		12.18	243,010.

[a] Millet did not enter into the optimal solution.

Simulated Effect of Increasing Milk Output. -- The following analysis simulates the effect of technological innovations which would increase the milk yield obtained from the two livestock enterprises while all other parameters (including grain prices) in the model are held constant at their original levels. Since the estimates of the value of output from the two livestock enterprises derived above indicate that more than half of the net value of output is obtained from milk production, technological innovations aimed at increasing milk yields should have a greater impact on increasing the relative profitability of livestock enterprises than would marketing interventions aimed at increasing animal prices. For this reason, the present analysis concentrates on the effect of increases in milk yields.

The average milk yields for goat and combined cattle and goat enterprises were 124 liters per U.B.T. for the former and 189 liters per U.B.T. for the latter. In conducting the parametric analysis, it was assumed that since observed milk yields from the combined livestock enterprise were 50 percent greater than yields from the goat herd alone, then the appropriate rate of increase of milk yields for the combined enterprise would also be 50 percent greater than the rate of increase for the goat herd. This is predicated on the assumption that yield-increasing technological innovations would have a greater impact on cattle than on goats.

Accordingly, the parametric analysis was conducted by forcing incremental increases in the value coefficients commensurate with increases in the goat milk yield of ten liters per U.B.T. per year and increases in the combined cattle and goat milk yield of fifteen liters per U.B.T. per year. In either case, the incremental increase corresponds to a rise in milk yields of 8 percent above original levels. Yields were made to increase in this fashion up to the point where the physical yield of milk from each enterprise was 50 percent greater than the initial yield.

In value terms, each incremental increase in yields corresponded to an increase in the value coefficient (c_i) of the goat enterprise of 500 F/U.B.T. and that of the combined enterprise of 750 F/U.B.T.[1] Therefore, the initial incremental increase in milk yields produced a 4 percent increase in the value coefficient for the goat enterprise and a 5 percent increase in the coefficient for the combined enterprise. At the maximum level of change associated with this analysis (an increase in yields corresponding to 50 percent of the initial yield), the value coefficients were increased to 24 percent and 27 percent over the initial levels for the goat and the combined cattle and goat enterprises, respectively.

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[1] Market surveys revealed that the prevailing price of milk during the survey year was 50 CFA F/liter.

The option of producing cattle was eliminated for the average Bush Tuareg model household, as it was for the previous analysis of grain prices. Therefore, for such households, the analysis was restricted to determining the change which would be required before the optimal size of the goat herd would increase to a level at which cattle could be introduced without undue risk. Once again, it was assumed that, as stated by the sample members themselves, cattle would not be introduced until the household had acquired a herd of at least twenty goats.

The results of such an analysis as applied to the average Bush Tuareg household are shown in Table 11. The results indicate that an increase in the milk yield of goats of twenty liters per U.B.T., or 16 percent, would raise the optimal size of the goat herd from eight to twenty-five head. Presumably, the increase would raise the relative profitability of livestock enterprises to the point where the household could comfortably introduce cattle. The solution remains stable as milk yields are increased further, and the only additional change in the optimal enterprise mix occurs when yields are increased to 1.5 times current levels.

When the same type of analysis was applied to the large Bush Tuareg model household with the goat/cattle enterprise in the objective function, the model generated the results given in Table 12. When compared with Table 11, the table shows that a 24 percent increase in milk yields would have the same effect as a 15 percent decrease in grain prices. Either change by itself would change the optimal size and composition of the herd from thirty-two goats and four to five head of cattle to twenty-eight goats and seven head of cattle. The same problem mentioned in the discussion of the previous analysis would be applicable to increases in milk yields beyond the level mentioned above, i.e., the model does not allow for

TABLE 11

EFFECT OF INCREASING MILK YIELDS ON LAND USE, GOAT HERD SIZE, AND THE NET VALUE OF OUTPUT FOR THE AVERAGE BUSH TUAREG HOUSEHOLD

	Crops (Ha)			
Change in Milk Yield (1./UBT)	Millet	Sorghum (average yield)	Goats (UBT)	Net Value of Output (CFA F)
0		2.31	1.66	140,034.
+ 10	2.39	1.70	3.60	141,588.
+ 20	3.21	1.28	5.07	143,802.
+ 30	3.21	1.28	5.07	146,336.
+ 40	3.21	1.28	5.07	148,869.
+ 50	3.21	1.28	5.07	151,402.
+ 60	.57	1.00	6.58	154,365.

TABLE 12

EFFECT OF INCREASING MILK YIELDS ON LAND USE, HERD SIZE, AND THE NET VALUE OF OUTPUT FOR THE LARGE BUSH TUAREG HOUSEHOLD

Change in Milk Yield (l./UBT)		Crops (Ha)		Livestock (UBT)		Net Value of Output (CFA F)
Goat Enterprise	Combined Goat/Cattle Enterprise	Sorghum (low yield)	Sorghum (average yield)	Goat Enterprise	Combined Goat/ Cattle	
0	0		2.82	2.67	7.33	299,696.
+ 10	+ 15	2.61	1.45	2.15	9.14	307,097
+ 20	+ 30	2.61	1.45	2.15	9.14	315,025.
+ 30	+ 45	3.45	1.00		11.16	323,024.
+ 40	+ 60	3.45	1.00		11.16	331,394.
+ 50	+ 75	3.45	1.00		11.16	339,765.
+ 60	+ 90	3.45	1.00		11.16	348,136.

a ratio of goats to cattle in the household herd of less than 4:1.

The initial increases in milk yields bring about the same effect on land use as did the initial decreases in grain prices. For the large Bush Tuareg household, the optimal area planted to grain increases along with the optimal size of the household herd as milk yields are increased by less than 24 percent of the original yields, or as grain prices are decreased by less than 15 percent of the initial prices. Similarly, for the average Bush Tuareg household, the optimal area planted to grain increases along with the optimal size of the goat herd as milk yields are increased by less than 50 percent of the original yields, or as grain prices are decreased by less than 25 percent of the initial prices. This suggests that either of the two policy initiatives could be combined with innovations aimed at alleviating binding labor constraints to avoid forcing a shift to less labor-intensive grain production technologies as livestock enterprises expand.

Basically, the effect of the two policy initiatives on labor constraints is to accentuate the importance of binding labor constraints just prior to and during the grain harvest. For instance, for the large Bush Tuareg household, the shadow price of labor in late September increases from 345 to 387 CFA F per hour as grain prices are cut in half and livestock enterprises are expanded and from 345 to 478 CFA F per hour as milk yields are increased by 50 percent. Late September is consistently the period when the shadow price of labor is highest and is increasing most rapidly as grain prices fall or as milk yields rise, thereby prompting an increase in the optimal size of livestock enterprises.

Similarly, for the average Bush Tuareg household not producing cattle, late October remains the period when the shadow price of labor is highest. As a rise in milk yields of up to 50 percent increases the optimal size of the goat herd, the shadow price of labor in late October increases from 399 to 445 CFA F per hour. As grain prices fall to half of their previous level and the optimal size of the goat herd increases, the shadow price of labor in that period is still the highest, although it decreases from 399 to 196 CFA F per hour. These two sets of results suggest that when combined with either of the policy initiatives examined in this section, complementary initiatives aimed at relieving labor constraints will have the greatest impact on increasing optimal herd size if they are designed to ease constraints occurring just before or during the grain harvest (i.e., during September and October). Methods of relaxing the constraints occurring during this period will be examined in the remainder of this paper.

Summary of Major Results

This section contrasts national development objectives with the objectives of the individual mixed farmer living in the pastoral zone, as reflected in the analysis. While the national objective may be to increase the production of cattle for export, residents of the southern pastoral zone subsist on grain, not cattle, and are reluctant to reallocate resources away from grain production. The social costs associated with continued grain production in the pastoral zone are contrasted in the following discussion with the desirability of grain and goat, but not cattle, production for the individual farmer.

Social Costs Associated with Current Production Patterns in the Pastoral Zone.-- Proponents of the stratification strategy feel that specialization in cattle production by residents of the pastoral zone is in the national interest and that the present allocation of land and labor resources to grain production in that area is inefficient. If this is indeed the case, then there must be some way to reallocate land and labor to cattle production in such a way that the welfare of some individuals can be improved either without adversely affecting anyone else, or by being able fully to compensate damaged parties and still have a net benefit to others. The national planners who advocate specialization believe that the revenues, and in particular the foreign exchange earnings to be gained from the sale of cattle to coastal countries, would provide the additional benefits to be expected from a more efficient resource allocation. The problem, as illustrated below, is that the individual mixed farmer does not perceive the same benefits to be gained from specialization in cattle production as those envisioned by the national planners.

Aside from the alleged opportunity cost associated with inefficient resource allocation in the form of continued grain production in the pastoral zone, there is an additional social cost associated with current production patterns which does not enter into the calculations of the individual producer. The cost in question is the reduction in value of the land resource caused by overexploitation by both crop and livestock producers. The history of land use in the southern pastoral zone illustrates the causes of the gradual deterioration of the resource base which has occurred during this century and which was accelerated by the period of drought which began in 1968. The first in this sequence of events is the subjugation of the Tuareg warlords by French colonial forces at the beginning of this century and the dissolution of the feudal system of land tenure which they enforced. The period following the pacification of the pastoral zone was one of abnormally high rainfall. The abundant rains, combined with the pacification of the Tuareg and the resultant availability of new land for cultivation, prompted a northward migration of Haussa grain producers during the two decades following the second World War.

Around the same time as the Haussa migration northwards, mechanized deep-bore water pumping stations were opened throughout the pastoral zone. The opening of the pumping stations attracted a larger number of Fulani herds than the area had supported previously. These herds also grew more rapidly as widespread cattle vaccination programs eliminated certain endemic diseases.

The influx of Haussa grain producers and Fulani cattle herders contributed to the devastating effects of the recent drought on the land resources of the pastoral zone. However, the pressure of increased population and the conflicting demands of the various production systems has not been relieved since the drought began. Rather than terminate grain production entirely and leave the area, Haussa grain producers and dispossessed Tuareg herders (Village Tuareg) have congregated in the market towns and have turned increasingly to commerce as the main source of household income. This tendency has been furthered in recent years by the growth in the importance of Kao and similar villages in the southern pastoral zone as the major livestock and commodity markets which service the pastoral zone have shifted north. This northward movement of the major livestock markets provided an alternative source of income for those village-dwellers who could no longer rely on their own grain production as a source of food. However, such households have continued to produce grain, often with the assistance of hired labor, since they have little to lose by doing so, their subsistence being assured by their income from trade. They can hire laborers to plant large areas of land, but avoid further costs merely by abandoning the field if the crop does not come up well. The system of land tenure may encourage such practices, as will be explained below.

Prior to subjugation of the Tuareg by colonial forces, the pastoral zone was, as its name belies, a region specialized in livestock production. Its success in this role was dependent on a system for controlling access to rangeland which was enforced by the Tuareg warlords. Most importantly, prior to this century, the southern portion of the pastoral zone -- including the area covered by the survey -- was set aside as a dry season grazing reserve. Animals were evacuated from the area during the rainy season, when they could take advantage of northern pastures. This system of seasonal migration allowed the pastures of the southern pastoral zone to develop during the rainy season so that livestock producers could rely on them as a source of forage once the rains stopped and pastures in the north had been exhausted.

However, with the expansion of grain cultivation and the influx of Fulani herds from the south, this system of seasonal migration, which allowed the pastures of the southern pastoral zone to develop during the rainy season, was abandoned. Obviously, few would benefit from a reinstatement of the Tuareg feudal system of land management. But in order to prevent further deterioration of the land resource and allow the pastoral zone to develop its potential as a breeding zone for livestock, some system of land management which encourages the protection of dry season grazing reserves must be introduced.

The challenge, therefore, is to find a system of land management which is enforceable and which limits, but does not preclude, grain cultivation, an activity which residents of the southern pastoral zone seem hesitant to abandon. Banning grain cultivation outright is not the solution. The 1961 law which defines the pastoral zone and which prohibits grain cultivation within it has never been effectively enforced. Part of the reason why it has not been effective is simply because it is contrary to the self-interest of the individual producer, as explained in the following section.

The Individual Farmer's Reluctance to Abandon Grain Cultivation and Specialize in Cattle Production.-- Despite the apparent national interest in promoting specialization in cattle production within the pastoral zone, the individual mixed farmers who inhabit the southern portion of that zone continue to allocate labor and land resources to grain and goat production rather than cattle. There are several reasons underlying this choice of activities. In the first place, over half of the mixed farm household's food needs, in terms of energy intake, are derived from grain consumption, whereas the consumption of livestock products contributes no more than percent of energy requirements. The only alternative to household production as a source of grain is the market, but residents of the pastoral zone have had unfortunate experiences with this means of obtaining grain. In particular, the fluctuations in the price and supply of grain on the market during the recent drought accentuated the hazards of relying on the market to provide such an important component of the household diet. Furthermore, increases in the price of fuel have raised transportation costs, which are passed on to the consumer in the form of higher prices for grain shipped to the pastoral zone from the agricultural zone to the south. Also, much of the grain which is offered for sale in the markets of the pastoral zone is of lower quality than that produced locally and stored in local granaries.

The linear programming analysis indicated that for Bush Tuareg households, increases in herd size beyond current levels would force a decrease in grain output. If the objective of development policy is to promote livestock production while confining the area planted to grain and conserving the quality of the land resource, confidence in the grain market must be developed. Policy recommendations along these lines are discussed in the following section.

Another reason why individual mixed farmers are hesitant to specialize in cattle production is the comparative advantage of the goat as a less risky source of food and cash income. There are several reasons why sample households -- and Tuareg sample households in particular -- preferred goats over other animal types. Goats are more resistant to the severe climate and particularly to drought conditions. They can browse trees and exploit sources of feed otherwise unacceptable to cattle, and their water requirements per standard animal unit are lower than the water requirements of cattle. They also offer several advantages for the herd manager in that they have less of a tendency to stray and require less attention than cattle. A young boy can handle a goat herd, but older males are more often required to manage cattle. The goat herd also is more manageable in that individual units within it are smaller and of lower value. Less initial investment is required than in the case of the cattle herd, and less risk is associated with the individual animal. Furthermore, goats can be sold to meet immediate cash needs, whereas the sale of cattle requires a larger disinvestment and more advance planning. For these reasons, it was found that mixed farmers were hesitant to diversify their livestock holdings by acquiring cattle until they had built up a herd of at least twenty goats.

Finally, the linear programming analysis indicated that Tuareg mixed farms desiring to expand their cattle herds faced labor constraints at the beginning and end of the growing season. In the simulation, as cattle herds increased in response to policy initiatives which raised the profitability of livestock enterprises relative to grain, the labor constraint just prior to the harvest in late September increased in importance. This is of particular significance, since rainfall during this period was less atypical during the survey year than in either of the other two periods (early July and late October) when labor availability restricted agricultural output.

The unusual rainfall patterns in early July and late October suggest that constraints which occurred at those times might not be as critical in years in which the rainfall distribution is closer to the average. In 1976, a thirty-day drought struck the survey area from late June to late July, in the midst of the growing season. The need to replant fields at the end of this period may have imposed a labor requirement which might not be present in years in which such a drought did not occur. Also, in 1976, rainfall in October was well above average, and as a result, the sorghum harvest was prolonged.

The unusually heavy rainfall at the end of the growing season may have distorted the labor requirements normally associated with harvesting.

However, there is no indication that activities were abnormally affected by rainfall in September 1976. The constraint which arose at that time came from the need to guard cattle to keep them away from the ripening grain while simultaneously guarding the grain fields to keep others' animals away from them. This suggests that the September labor constraint is not only the most important in terms of the increasing opportunity cost of labor as cattle herds expand, but also that it is the most likely to persist under different rainfall conditions. The need to guard the animals as well as the grain fields just prior to the harvest will always be a problem. The following section presents some attempts to resolve that problem as well as others raised by the results of the formal analysis.

Policy Recommendations

The previous section has illustrated the extent of the disparity between national and individual objectives. The present section discusses a set of policy recommendations which might reconcile the two viewpoints. These policy recommendations are aimed at increasing cattle production by mixed farmers in the pastoral zone while restricting the area planted to grain and preserving the quality of the land resource. The analysis thus far has indicated that policies aimed at increasing the relative profitability of cattle production will not of themselves be sufficient to divert land and labor resources away from grain and into cattle production. Such policies must be accompanied by complementary initiatives. Structural changes are required in addition to simple marginal changes in technologies and prices. One such initiative proposed below is the attribution of seasonal property rights to livestock producers, which could relieve the September labor constraint, preserve the quality of the land resource, and to some extent internalize the social costs associated with the overexploitation of land. Associated land tenure reforms which would discourage those who have alternative sources of income from continuing the expansion of grain production would be another complementary initiative.

The introduction of labor-augmenting changes in grain production technology would enable labor resources to be reallocated from grain to cattle production without decreasing grain output or increasing the area planted to grain. However, this approach does not respond to the problem of protecting the land resource. A more appropriate strategy, which would respond more directly to the concerns of the individual producer, would be the development of the market as an alternative to household grain production. Along the same lines, development projects aimed at goat production might enable the relatively impoverished producer to expand into cattle production more rapidly. Specifically, increases in the milk yields of goats might decrease the size of the subsistence herd required to assure a steady milk supply prior to diversification into cattle. These alternatives are explored in the following discussion.

Increasing the Relative Profitability of Cattle Production.-- The linear programming analysis has indicated that the production of grain is currently a rational choice of activities for the profit-maximizing producer. The actual choice of grain and livestock production activities by Tuareg mixed farmers is now close to optimal levels indicated by the model. One approach to altering this choice of activities and bringing it more in line with the national objectives outlined above would be to increase the relative profitability of cattle production.

Three policy options which would embody this approach were examined in the formal analysis. The first consisted of grants of animals to mixed farmers. Such programs have been underway for the past several years, but their outreach has been limited to Fulani herders currently specializing in cattle production. Using the techniques of parametric programming, the analysis indicated that if such programs were to include mixed farmers, they would have relatively little impact on cattle production unless accompanied by programs aimed at relieving the labor and subsistence constraints embodied in the model. Without such complementary programs, increasing the size of herds held by Tuareg mixed farmers beyond current levels would force a shift to more land-extensive grain production technologies and a commensurate decline in the net value of agricultural output. Such a shift would hardly be desirable. Also, as the analysis indicated, the shift to more land-extensive technologies would involve allocating more land to grain production in order to fulfill the household's subsistence needs.

Two policy alternatives which might shift the economic advantage to livestock production were selected for analysis. The first was to lower the relative price of grain, and the second was to increase milk yields. The two initiatives suffered similar fates in the simulation. The expansion of the herds as a result of the increase in the relative profitability of livestock production was accompanied by an increase in the area planted to grain caused by a shift to less productive grain technologies. The shift to less productive grain technologies as the cattle herd expanded was made necessary by the increase in the importance of the September labor constraint. The following policy approaches are designed to address this problem.

The Extension of Seasonal Enforcement of Property Rights to Livestock Producers.-- Currently, the only legally-enforceable private interest in land recognized in the survey area is the right of the grain producer to cultivate his fields without interference from trespassing herds. If trespass by animals results in actual damage to the crop, no matter how slight, a cause of action arises, and the grain producer may bring his claim before a local tribunal headed by the local Haussa village chief. Judgements are enforced by armed nomad guards. The decisions of the tribunal rarely favor the trespassing herder.

On the other hand, no comparable protection is offered to those who wish to develop the land for purposes of livestock production by improving the pasture of cultivating forage crops. The ultimate effect of this policy is to provide an initiative for the grain producer to expand the area he has planted to grain, since this is the only effective way to gain a private interest in the land. No similar incentive exists for the livestock producer. There is no means by which the livestock producer can set aside a plot of land as a dry season grazing reserve and enforce his rights when this plot is encroached upon.

If the legal protection currently extended to grain crops during the rainy season were to be extended to producers of forage crops or other inputs to livestock production, the sometimes conflicting demands of grain and livestock production might by resolved. Furthermore, the expansion of the private property rights of livestock producers might stimulate livestock producers to make improvements in the land which would preserve its quality and prevent further desertification. This does not necessarily imply a shift away from the priority goal of supplying sufficient grain for the population if grain production technologies which yield higher returns to land can be implemented.

The following is an example of how such a system might function. An individual livestock-producing household, or a cooperative, would agree to make certain improvements on the land, such as the production of forage. A land management bureau established at the regional level of the Livestock Service could maintain agents at the village level who would distribute grass seeds, provide extension services, and settle disputes over damage done to the forage crop. Such a program would not only preserve, but improve the quality of the land. The extension of private property rights to such individuals or cooperatives would also be consistent with the tenets of Islamic law, as long as some improvements on the land are made.

The household could mark its allotted land by a thorn-brush fence, and the right to an action for damages would arise whenever this fence is breached and the encroaching animals consume the forage which is developing on the plot. In addition to the agreement to make improvements, the only condition which would need to be imposed upon the individual claiming the property interest would be that he not allow his own animals to consume the developing grasses until the latter part of the rainy season. This would ensure that the grasses be allowed to develop and avoid the problems involved in allocating the damages between the owner's animals and those which committed the trespass. Furthermore, the suit for damages could only be brought if the trespassory act occurred during the rainy season when the grasses were developing, up to the time when the owner decided to let his own animals graze on the plot.

Outside of the rainy season, no individual property interest would be recognized and, just as in the case of the grain fields, the land would revert to public rangeland.

This scheme, if effective, might provide an incentive for protecting grasses during the rainy season. The point in protecting the grass cover during the rainy season is to allow it to develop. The rainy season is the time when such protection is most needed, since this is the time when plant growth takes place and when a healthy grass cover can prevent soil erosion. Also, if the grasses are not consumed as they grow, a larger crop of grass seeds would result, and the quality of the range in the following year would be improved.

Such legal protection combined with an appropriate extension program might result in benefits for the producers as well, if it encourages Tuareg mixed farmers to produce forage or to set aside reserves during the rainy season. The linear programming analysis indicated that, as the cattle herd expands, most of the available September labor must be devoted to guarding the animals to prevent them from encroaching on the grain fields and consuming the ripening grain. If the attribution of property rights to livestock producers does stimulate the setting aside of pasture reserves, the labor requirements of livestock enterprises during the critical September period might be reduced by confining the animals to the plot which had been set aside during the rainy season. This would alleviate the September labor constraint, if little additional work is required to confine the animals to the plot.

Another desirable aspect of this alternative is that it provides a system of land management based on existing institutions. There would be no reduction in the rights of grain producers to bring an action to recover damages caused by trespassing herds, although a strong argument can be made for revising the procedure by which such rights are enforced. This approach involves only the extension to livestock producers of rights to bring a similar action. Possibly, the involvement of a Livestock Service agent in the dispute settlement procedure might promote more equitable solutions. In any case, it is apparent that some procedural reform is required at the village level for the approach to be effective.

Several problems must be overcome, in addition to procedural reform, before such an approach can accomplish the goals of resolving property disputes or protecting the environment. The primary problem is that currently there is no system for recording interests in real property. Since the forage plot requires less in the way of obvious improvements than a plot planted to grain, disputes may frequently arise concerning ownership of the interest in a given forage plot. This problem can be resolved partially by stipulating that the interest can only be claimed upon the erection of obvious improvements, such as a thorn-brush fence and the performance of acts indicating an intent to exclude all animals from the plot. Furthermore, the term of the interest should be for only one rainy season, renewable in subsequent years by the maintenance of the fence, improvement of the grass cover and acts indicating the intent to exclude animals.

The second problem is that transit corridors must be maintained for herds moving through the area to northern pastures. This could be accomplished by limiting the areas in which forage plots could be claimed. Again, the lack of a system for recording property interests poses a problem. It may be necessary to have a tribunal at the regional level to apportion lands to each group and to settle disputes over conflicting claims. This would add an unrealistically heavy judicial and administrative burden. A more realistic alternative would be to limit either the allowable compensation for damages or the amount of land which could be claimed for forage crops. This would discourage producers from claiming too large a plot and thus cutting into the land which would otherwise be available for transit corridors. The latter alternative would lend itself more readily to self-administration.

The intention of the scheme is to provide a means of protecting the grass cover during the rainy season and of resolving the conflicting demands of grain and livestock production. The recognition of a limited property interest akin to the interest of the grain cultivator in his land during the rainy season might accomplish these objectives. However, additional information on technical coefficients is required before the feasibility of forage production can be confirmed.

Associated Land Tenure Reforms. -- A problem related to the above is that current property laws in Niger, as they were explained to this author by a local government official, recognize a more permanent interest in land than that mentioned above once a household has planted a given plot to grain for three consecutive years. The ability to acquire more permanent rights to the land merely by continuing to plant grain is an additional incentive to village-dwellers to continue grain cultivation, even though they have an alternative source of income from trade which makes the cultivation of grain for subsistence unnecessary. These rights must be renewed each growing season by planting, but there is no requirement that the owner continue to cultivate the entire field through to harvest in order to maintain his rights to the entire parcel. Furthermore, the planting requirement may be fulfilled by hiring laborers to plant and weed for the first few months of the season, thus avoiding the need to allocate household labor to these tasks. Then, once the plants have sprouted, the farmer can abandon the field altogether while maintaining his permanent interest in it and his right to sue for damages if trespassing herds encroach upon it.

Alternatively, once a more permanent interest is acquired, the farmer can lease his land to households which are unable otherwise to obtain land,and have his tenants plant and cultivate his parcel. The farmer may demand additional services from the tenant's household, such as assistance with domestic chores or labor on other fields owned by the lessor. The produce from the plot thus loaned is normally the property of the tenant, but the system allows the landlord to maintain his more permanent interest in the property while obtaining additional labor services as a form of rent.

It is obvious from the above description that such practices are in need of reform. The incentive to put land into grain production, even without the intention of bringing the crop to fruition, must be eliminated. While the ability to acquire a permanent interest in land through continued cultivation may provide a necessary and useful incentive for grain producers in the agricultural zone to the south, it is clearly a detrimental policy in the pastoral zone.

Labor-Augmenting Change in Grain Production Technology. -- An alternative approach to relieving the September labor constraint and avoiding the necessity of shifting to less productive grain technologies as cattle herds expand would be to introduce changes in grain production technologies which would increase labor productivity. A simple example of such technological change would be the introduction of grain varieties which mature more rapidly. This would shorten the waiting period between the August weedings and the October harvests, when fields must be guarded to prevent animals from destroying the crop. The decrease in the labor requirement would enable mixed farmers to complete the harvest earlier, thereby leaving them more time to devote to livestock production. Possibly, the reduction in labor requirements during the harvest season would also prevent having to shift to more land-extensive technologies once the cattle herd expands.

The result of such an effort, however, would be at best to hold constant the area planted to grain by eliminating the need to increase the area planted in order to meet the household's subsistence needs as cattle herds are expanded. On the other hand, such technological changes may even result in an increase in the area planted to grain due to the increase in the relative profitability of grain enterprises. Given the development objectives of encouraging cattle production while restricting grain production, the development of substitutes for household grain production may be a preferable approach.

Developing the Market as an Alternative to Household Grain Production.--The linear programming analysis indicated that Tuareg mixed farmers are constrained from expanding their cattle herds by the desire to produce enough grain to meet subsistence requirements. Although in some cases, profit-maximizing behavior alone would dictate an increase in the cattle herd and the use of the increased income from the larger herd to purchase grain for the household, Tuareg households refrained from doing so due to a lack of confidence in the market, particularly as a source of supply for such an important component of the household diet. It is therefore necessary to build confidence in the market as a source of grain before the development objectives listed above can be attained.

An assured supply of cheaper, high-quality grain to the local market could create greater confidence in the market as a source of grain and thereby increase the relative attractiveness of livestock enterprises. To achieve such confidence, the grain appearing on the market would have to be of comparable quality to the grain produced by the households themselves and would have to be slightly cheaper and more consistently available than was the case during the survey year. This effectively precludes any effort on the part of the government grain marketing board (OPVN), unless that agency adopts a more realistic storage policy by allowing agents to get rid of rotting and infested grain rather than allowing it to contaminate new grain shipments in the warehouse. It is possible that the paved road which is scheduled to link the Azawak region with the two regional capitals at Agadez and Tahoua will help to assure more regular and less expensive grain supplies from the south.

The Development of Goat Production. -- The goat, rather than the cow, is the basic component of the Bush Tuareg livestock enterprise. The smallest and least wealthy households are likely to own one or two goats, and even the largest Bush Tuareg household strives to maintain a herd of twenty to thirty goats in addition to its cattle holdings. The fact that goats are more common to households in the northern Sahel raises the question of whether development programs for that area should not concentrate on, or at least pay some attention to, the development of goat production. Certainly, if the intention of a development program is to have some immediate impact on the well-being of the least wealthy households, a cattle production project is not in order. Rather, one would anticipate that a project aimed at increasing and prolonging the milk yields of traditionally-managed goat herds would have a greater immediate benefit for a larger number of households, including the least wealthy.

Furthermore, the desire to build up a subsistence herd of at least twenty goats before diversifying into cattle production currently limits the ability of the average household to produce cattle. The subsistence herd of goats is required to assure a supply of milk for the household, since the output of milk from small cattle herds is less certain. An increase in the milk yields of goats might reduce the number of goats required for the subsistence herd, and enable households of average size to acquire and manage the small cattle herd which the linear programsusing model indicates as optimal once the goat herd constraint is eliminated.

Conclusions

The above policy recommendations suggest ways in which the reality of the individual farmer's needs and motivations might possibly be reconciled with development objectives that are in the national interest. The recommendations stem from the basic disparity noted in the previous section of this paper. Although cattle exports are an important source of foreign exchange earnings, although social welfare in the pastoral zone may be maximized by specialization in cattle production, and although continued grain production and uncontrolled land use in that area is resulting in a steady deterioration of the quality of the land resource, extensive grain production is still in the private interest, and individual farmers continue to devote their efforts to grain crops. Few mixed farmers in the pastoral zone find themselves able or willing to specialize in cattle production, or even to increase cattle production at the expense of their grain crops. National objectives may simply be incompatible with those of the indigenous population, most of whom are only peripherally involved in cattle production.

Programs aimed at increasing the attractiveness of cattle production to mixed farmers might have some impact on increasing the number of cattle held by them in the southern pastoral zone. However, it is unlikely that marginal changes in technologies and prices alone will be effective in reducing the area planted to grain and preserving the quality of the land resource. To accomplish such objectives would require structural reforms such as reforms in property law and the development of confidence in the grain market as an alternative to household production. In addition, complementary programs to develop the productivity of goats would enable less wealthy households to reach the position where they can assume the risks associated with cattle production.

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A MODELING OF THE DEMAND AND SUPPLY OF FOOD GRAINS IN SENEGAL

by

Clark Ross

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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ABSTRACT

In this paper the author estimates demand and supply for principal food grains until the year 2000 in Senegal. These are projected under a variety of assumptions for the hypothesized independent influences -- income, grain prices, population, crop yields, and acreage. The demand for grain is calculated using a range of price, cross-price, and income elasticities. For all sets of assumptions continued rice deficits are derived. With most supply-demand scenaria overall grain deficits also are projected. Finally, possible means to reduce or to eliminate these deficits are considered. Price policy, continued rice imports, and irrigation projects are briefly considered.

SOMMAIRE

Dans ce rapport, l'auteur estime les courbes d'offre et de demande pour les céréales alimentaires principales au Sénégal jusqu'à l'horizon 2000. Ces fonctions sont évaluées pour le futur à partir d'hypothèses variées concernant des facteurs jugés indépendants tels que le revenu, les prix céréaliers, la population, les rendements des cultures, et la superficie cultivée.

Les courbes de demande de grain sont calculées d'aprés une gamme d'élasticités par rapport au prix et au revenu, et d'élasticités croisées. Chaque combinaison d'hypothèses mène à l'estimation d'un déficit en riz. La plupart des combinaisons offre-demande entraine aussi un déficit céréalier total net. Enfin, certains moyens de diminuer ou d'éliminer ces déficits sont éxaminés, ainsi que les conséquences de la politique des prix, de la poursuite des importations de riz et des projets de culture irriguée.

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CHAPTER I - MAJOR OBJECTIVES AND PLAN OF WORK

Attaining and assuring an adequate food supply has generally been a priority of most countries throughout history. Recently the Sahelian countries of West Africa have enunciated the more specific goal of domestic food-grain self-sufficiency. This commitment has been accepted both by the CILSS member countries and various international donor groups.[1] At the outset it should be emphasized that a reliance on domestic food production is not necessarily equivalent to an assurance of food supplies. This is particularly true in the Sahel where variable rainfall patterns imply relatively large risk associated with agricultural production. Finally, it should be noted that food grain supplies can, depending upon contractual, economic, and institutional conditions, be reasonably well assured through international trade, i.e. import.

In Senegal approximately 30 percent of domestic food grain consumption can be classified as imported. Rice (200,000 tons in 1976) and wheat (100,000 tons in 1976) form the near totality of these commercial imports. These imports are primarily financed through export earnings from groundnuts. Essentially Senegal has been pursuing a strategy of comparative advantage and integration with the world economy. While committed to eventual domestic food grain self-sufficiency, the Senegalese recognize that an immediate and total replacement of these imports is unlikely. A gradual reduction in grain imports is to be achieved through national policy affecting both the supply and demand of food grains. Production programs aimed at major increases in domestic rice and maize production, as well as a modest increase in millet production, are incorporated in the Senegalese national plan. Further, a change in the composition of demand towards increased millet and maize consumption with a commensurate reduction in rice consumption is envisioned.

The purpose of this study is to evaluate the probable success of the Senegalese policies to achieve increased self-sufficiency. Such a broad task requires a modeling of Senegalese grain demands and supplies. On the demand side, per capita regional demand equations for grains will be specified; these equations can then be aggregated to project national grain demands.[2] The supply side, due to the inability to specify accurately production functions and producer responses, will be less formally developed. However, as will be explained in Chapter II and tested in Chapter III, some attempt at estimating domestic grain supplies for benchmark years will be made.

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[1] Committee for the fight against drought in the Sahel (CILSS) comprised of the following countries: Senegal, The Gambia, Mauritania, Niger, Mali, Upper Volta, Chad, and the Cap Vertian Islands.

[2] Certain benchmark years like 1985, 1990 and 2000 will be selected.

From this modeling exercise a number of specific questions can be addressed:

1. Based on current prices, the per capita demand equations, and population estimates, what will national grain demands be in 1985, 1990 and 2000?
2. Without changing the structure of demand, what consumer grain prices would achieve the Senegalese government's per capita grain consumption targets, which incorporate a change in the composition of demand?
3. Assuming a continuation of current agricultural practices and per hectare yields, what will the projected domestic grain supply be in future years?
4. What will be the marginal impact on projected supply from (a) extension efforts which succeed in increasing per hectare yields (b) a change in the relative allocation of resources from groundnut to domestic grain cultivation (c) the planned infra-structure investments (along the Senegal, Gambia, and Casamance Rivers) to increase lands cultivated under irrigation?

Integrating the supply and demand estimates will provide, based on the assumptions selected, projected grain imports, consumer prices needed to equilibrate grain markets, and subsidy expenses needed to achieve government demand targets.[3] Obviously, the above issues can be evaluated with differing combinations of demand and supply assumptions.

There are many benefits to this type of investigation. First, simple projections needed by national planners and donor groups can be generated. Second, the sensitivity of projected demands and supplies to various key parameters like price, price elasticity, rate of population growth, and yield increases, can be assessed. Third, this exercise provides a framework for aggregating the potential effects of the various, regionally decentralized development schemes which have been planned for Senegal.

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[3] A subsidy would be required if the consumer price needed to induce the per capita consumption were less than the required supply price, including all intermediate expenses.

Fourth, potential conflicts in Senegalese planning objectives can be uncovered. Finally, a modeling methodology useful to planners will have been developed. As additional information about the Senegalese agricultural sector becomes available refinements to increase the preciseness of the models' predictions can be made.

The purpose of this exercise is not to promote a particular strategy for achieving food grain security, but rather to provide a framework for analyzing the implications of alternative strategies with various underlying parametric assumptions. Senegalese planners and interested donor groups, after reviewing the implied costs and benefits of these strategies, must devise an agricultural policy for food grain provision.

Chapter II will discuss in greater detail the derivation of the supply and demand components of the model. In Chapter III various empirical estimates of demands and supplies will be presented. Projected grain balances generated from integrating domestic supply and demand under a variety of parametic assumptions will be presented in Chapter IV. The major implications of particular strategies to assure adequate grain supplies (i.e. imports versus domestic production) will be discussed in Chapter V. Finally, in Chapter VI the key recommendations from this study, the needed refinements to the modeling process, and important data deficiencies will all be noted.

CHAPTER II - METHODOLOGY OF THE ANALYSIS

Having established the importance of designing an effective food policy for Senegal, it is now appropriate to present the reader with the methodology used in this study. Essentially, this study aims to construct a framework within which various food policies can be evaluated under a variety of assumptions. These assumptions include those concerning grain prices, income, population growth, and the Senegalese agricultural development effort. Depending on the specification of the model, key effects or impacts on prices, subsidies, grain balances, and nutrition can be estimated. Testing the sensitivity of these results to crucial parameters like price elasticity, income growth, and population growth allows the policymaker to assess the confidence limits within which the results, recommendations, and conclusions of a proposed strategy can be placed.

Section 1 - Derivation of National Grain Demands

The procedure for estimating national grain demands is (1) to partition Senegal into geographic regions based on current grain consumption patterns, (2) to derive per capita grain demand equations for each region and (3) to estimate each region's base population (1976) with a projected annual growth rate. With these data items, regional and national grain demands can be derived for given parametric values and assumptions.

Each of the three components of the demand estimation procedure warrant elaboration.

A. Regional Disaggregation

For the purpose of calculating demands, Senegal is divided into the following four regions:[4]

I. Urban Dakar - which includes the approximate 832,000 (1976) urban residents of Dakar, Pekine, and Rufisque.

II. Groundnut Basin and Rural Cap Vert - which includes the departments of Louga, Thiès, and Diourbel; as well as the major portion of the Sine Saloum.

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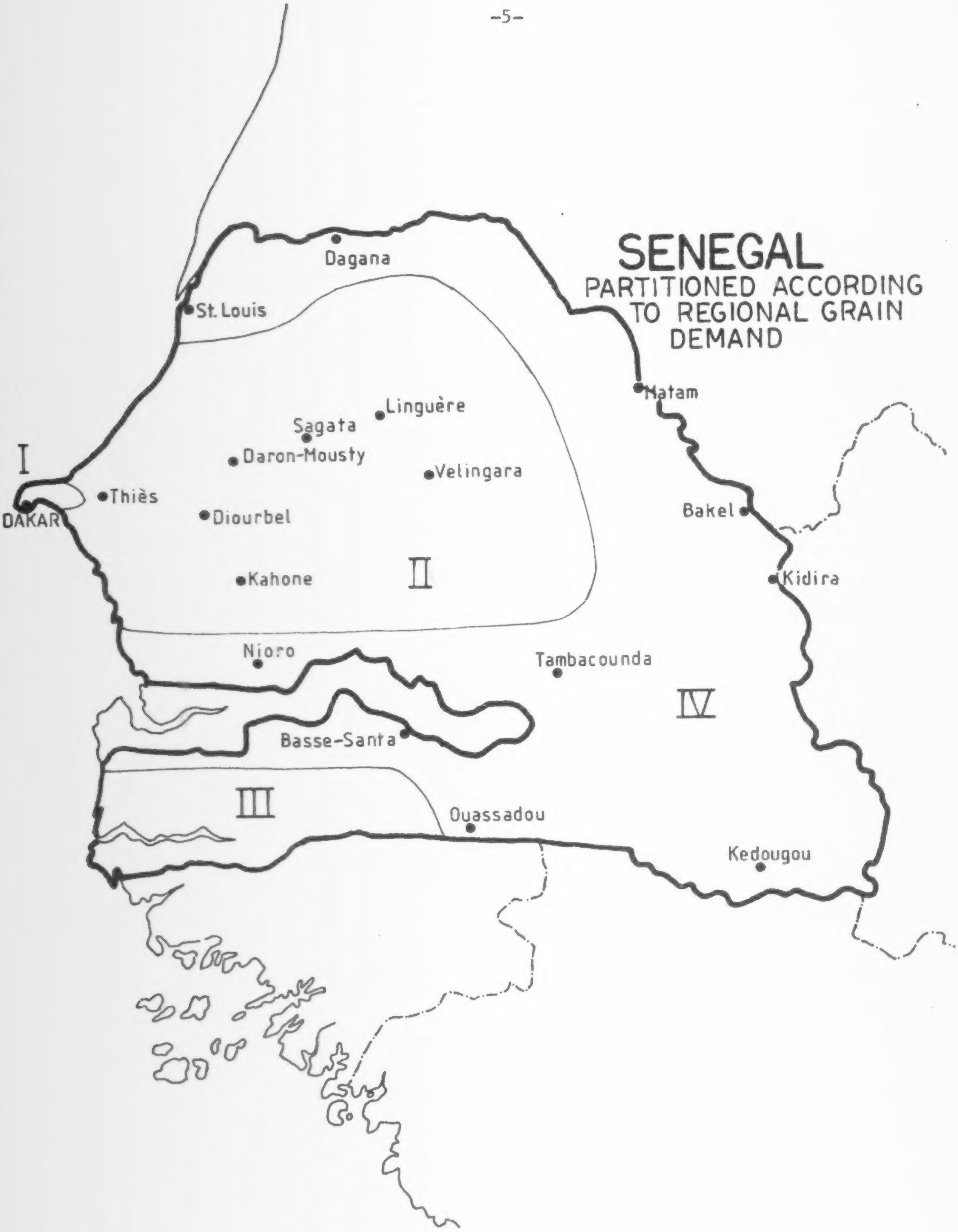
[4] The accompanying map will aid in situating these four regions.



SENEGAL
PARTITIONED ACCORDING
TO REGIONAL GRAIN
DEMAND

Dagana
St. Louis
Matam
Linguère
Sagata
Daron-Mousty
Velingara
I
Thiès
DAKAR
Diourbel
Bakel
Kahone
II
Kidira
Nioro
Tambacounda
IV
Basse-Santa
III
Ouassadou
Kedougou

III. Casamance Region - which includes all of the Casamance administration region with the exception of an approximate 102,000 residents (1976) who are more properly classified in the Gambia River Basin.

IV. Fleuve and Gambia River Basin - which includes the populations of the Senegal River Basin and the Gambia River Basin (including portions of the Sine Saloum, Casamance, and all of Senegal Oriental).

Disaggregation of Senegal's population is vital, in recognition of the diverse patterns of grain consumption currently observed among the regions.

B. Per Capita Demand Equations

For each principal grain - millet, rice, and maize - and within each of the four regions identified, a per capita demand (KG/year) equation is needed. Each of the 12 grain demand equations has the following independent variables - a constant, own per kilogram price, prices of the other two grains, and per capita income. Thus, each grain demand function has an associated own price, two cross-price, and an income elasticity. The exact formulation of the per capita demand equation is: $Q_{ij}=a_{ij}+\sum_{i=1}^{3} b_{ij}P_{ij}+c_{ij}Y_j$ where

Q_{ij} = quantity demanded of the ith grain in region j (kg/year)

P_{ij} = price of the ith grain in region j (CFA/kg)

Y_j = annual per capita income in region j (CFA)

The coefficients (a's, b's, c's) for these equations were calculated in the following manner:

1. Mean annual (1976) per capita consumption of each grain was estimated by region. These estimates are from the following sources:

Region I - Study of consumer grain demands in Dakar, Senegal.[5]

Region II - Study of producer grain transactions in rural Senegal.[6]

Region III and IV - Gambia River Basin Development Commission work, Casamance River Development work, and SONED study.[7]

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[5] Ross, Clark "Grain Demands and Consumer Preferences, Dakar, Senegal."

[6] Ross, Clark "A Village Level Study of Producer Grain Transactions in Rural Senegal."

[7] SONED, Etude sur la Commercialization des Cereales au Sénégal, Dakar, Senegal 1977.
Unpublished work by the author for the Gambia River and Casamance development projects.

2. Own price, cross-price, and income elasticities at the mean were then estimated. Mean grain prices and incomes in each of the four regions are available from the same sources. The elasticities for Region I are derived when possible from the empirical results of the Dakar grain consumption study. Elasticities in other regions are essentially "best estimates" consistent with those sources of information previously referenced. These latter elasticity estimates, since they generally do not originate from actual budget studies, are undoubtedly subject to error. Assessing the sensitivity of projected grain demands to changes in these elasticity estimates will be done in Chapter III.

Having estimates of the various elasticities, the coefficients for the independent variables, the b's and c's in the above demand equations, can be calculated. Using the mean value for the dependent variable and for the particular independent variable, the following relationship from the definition of elasticity is used to derive the coefficients:

$$(1) \quad \overline{E} = \frac{dY_D}{dY_I} \cdot \frac{\overline{Y}_I}{\overline{Y}_D} \text{ or } \overline{E} = b_I \cdot \frac{\overline{Y}_I}{\overline{Y}_D}$$

$$(2) \quad b_I = \frac{\overline{Y}_D}{\overline{Y}_I} \cdot \overline{E}$$

With estimates for each elasticity (own price, cross-price, and income), all coefficients can be derived. Solving for the constant term in each equation becomes trivial once these coefficients have been calculated. Using mean values for the independent and dependent variables, and the calculated coefficients, the constant is the only remaining unknown in each equation. Having solved for the constant, the demand equation is now expressed in the desired form. These per capita demand equations will be shown in Chapter III.

Thus, for each grain within each region, an annual per capita demand equation has been formulated as a function of each grain price, income, and a constant. To test the predictive power of each equation, various price combinations will be posited and the resulting demands assessed in Chapter III. Also, as stated, the sensitivity of the resulting demands to changes in the assumed elasticities will be evaluated.

C. Regional and National Grain Demand

For any year, regional demand can be estimated by multiplying the projected per capita demand by the assumed regional population. Base year (1976) population estimates are from the recently terminated census of the Senegalese population. Future population estimates were generated on the assumption of a 4.0 percent annual urban growth rate and a 1.9 percent annual rural growth rate. This weighted (at the base year) growth rate of 2.6 percent is that used by Senegalese planners in their Food Investment Strategy for 1977-1985.[8] National demand, of course, is simply the sum of the four regional demands. Within the next chapter projected grain demands until the year 2000 will be presented for a variety of parametric assumptions. It is now appropriate to discuss the procedure for specifying the supply side of the model.

Section 2 - Derivation of Agricultural Supplies

Due to the inability to specify accurately the appropriate agricultural production functions, the derivation of the supply side of the model will be less rigorous than that of the demand side. Seven geographic regions of Senegal, those identified in national planning documents, will be considered. These regions are: Cap Vert, Casamance, Diourbel, Fleuve, Senegal Oriental, Sine Saloum, and Thiès. The sum of crop production from these seven regions will be equivalent to the national domestically produced supply of that crop. To calculate the amount of any crop available for consumption, the domestic supply must be reduced by estimated post-harvest and milling losses.

Production of the ith crop will simply be defined as yield per hectare (Y_i) multiplied by the hectarage cultivated in that crop (H_i). Senegalese planning documents give relatively complete base data for yields and hectarage in each of the seven regions listed above.[9] These data have been accepted for the purposes of this model, and constitute the base from which the future production estimates described below will be made.

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[8] Government of Senegal, Food Investment Strategy, Dakar, Senegal, 1977.

[9] Ministry of Planning, 1976-1980 National Development Plan, Dakar, Senegal, 1977.

A. Autonomous Supply Growth

In this first case both hectarage and yields are assumed to increase over time by a trend factor. For hectarage these increases are between .5 and 2 percent per year, depending on the availability of land in the particular region. Such increases are assumed to be in response to rural population growth. Yield increases will be an important parameter for sensitivity testing. Both unchanging yields per hectare and increases of 2 and 3 percent per annum will be used in this modeling. Thus, production (S) for crop i in year t in region r will be defined as:

$$S^r_{i,t} = \left[Y^r_{i,to} \quad (1 + g_{i,r})^{t-to} \right] \quad X \quad \left[H^r_{i,to} \quad (1 + h_{i,r})^{t-to} \right]$$

where $g_{i,r}$ is the annual growth rate for yield per hectare of the ith crop in region r

h_{ir} is the annual growth rate of hectarage of the ith crop in region r

Y = yield (kg/ha), H = hectares

Summing the regional productions gives the estimated national production of each crop.

B. Senegalese Planned Production

In this case those growth rates envisioned in Senegalese planning documents for yields per hectare and hectarage in each region will be accepted and tested. These rates are considerably more ambitious than those assumed in Part A of this discussion. Yields per hectare for some crops are assumed to increase by as much as 20 percent with hectarage increasing by as much as 30 percent. While this study does not proport to give a definitive assessment of the technical feasibility of these goals for yields and surface, this modeling will give some indication of the reasonableness of these goals, particularly in comparison with the production estimates from Part A.

C. Incorporation of Major Development Programs into Supply

In conjunction with the international donor community, the Senegalese are studying major development of their three river basins, the Senegal, Gambia, and Casamance. Related projects and programs could range from modest intensification of traditional agriculture to major infra-structure construction including multi-purpose dams for electricity and hydro-agriculture. To estimate accurately future grain supplies, some account must be taken of these planned efforts. More importantly, the aggregate effects of these three potential development projects should be considered and assessed. Each river basin planning agency has essentially been chartered as a decentralized entity, responsible for planning and project coordination in its own basin area. However, it is difficult and grossly inefficient for each of these agencies not to consider potential developments which may emanate from the other basin areas. This study, by considering a range of possible developments in each of these basins, should contribute to a more coordinated planning effort. These major developments will be considered in Chapter V where various strategies for food security are discussed.

Thus, as with the demand side of the model, this study will consider a number of potential supply scenaria. The sensitivity of the domestic supply estimates to yield changes and surface growth can be accommodated with this analysis.

Section 3 - Integration of the Demand and Supply Components

The integration of the demand and supply sub-models, the topics of Chapter IV and V, will provide insight into a number of areas of interest to policymakers. These are mentioned below:

A. Supply/Demand Balances

Projected demands and supplies for grain crops -- millet, maize, and rice -- can be compared under a variety of parametric assumptions. Initially, the now prevailing prices will be used in this analysis; however, the model can incorporate either changes in the grain price level or changes in the relative prices of grains. Initially, this analysis will permit the calculation of projected excess demands and/or supplies for the various grains. Policymakers can then assess the possible means to mitigate problems of excess demand or supply; these could include imports, exports, price policy, or rationing.

B. Price Derivation With an Exogenous Supply

Based on the projected supplies and the hypothesized demand functions, those prices needed to equilibrate individual grain markets can be derived. The implicit assumption here is one of no grain imports; this, of course, can be relaxed to accommodate any exogenous level of imports desired. The policymakers can then assess the economic and political rationality of the calculated prices. For instance, the needed rice price may be at a politically unacceptable level. In contrast, the calculated consumer millet price may be sufficiently low that its associated farm price will not elicit the projected supply without costly national subsidies. Chapter III will now present the data elements used in this analysis and will show, with a minimum of discussion, the major empirical results from the supply and demand sub-models.

CHAPTER III - GRAIN SUPPLY AND DEMAND ESTIMATES

In Section 1 those data elements used in this analysis of Senegalese grain demand and supply will be discussed. In Sections 2 and 3 demand and supply estimates under a variety of parametric assumptions will be presented, with the sensitivity of these estimates assessed.

Section 1 - Derivation of Initial Demand and Supply Components

A. Population

As stated in Chapter II, the Senegalese population has been disaggregated into four geographic regions for this analysis. These regions primarily differ by the composition of the typical grain diet. The estimated current grain consumption within each of these regions is shown in Table II. Table I details the base (1976) population for each region, as well as the estimated populations in 1980, 1985, 1990, and 2000.

Table I - Population of Senegal (000's)

			1976	Annual Growth Rate %	1980	1985	1990	2000
1.	Urban Dakar	U	832	4.0	973	1184	1440.7	2132.7
		R	0	1.9	0	0	0	0
2.	Groundnut Basin	U	417	4.0	487.8	593.5	722.1	1068.9
		R	2108	1.9	2272.8	2497.1	2743.5	3374.6
3.	Casamance	U	126	4.0	147.4	179.3	218.2	323.0
		R	513	1.9	553.1	607.7	667.7	821.2
4.	Fleuve and Gambia River Basin	U	154	4.0	180.2	219.2	266.7	394.8
		R	965	1.9	1040.4	1143.1	1266.3	1544.9
	Country	U	1529	4.0	1788.4	2176	2647.7	3919.4
		R	3586	1.9	3866.3	4247.9	4677.5	5740.7
	Total		5115	2.68[a]	5654.7	6423.9	7325.2	9660.1

Where: U = Urban Sector
R = Rural Sector

a = annual growth rate of total population between 1976 and 2000.

An approximate 90 percent increase in the Senegalese population is envisioned during the 1976 - 2000 period. More importantly, a 150 percent increase in the urban, nongrain producing, population is projected. Such an increase would raise the urban sector's proportion of total population from 30 to 40 percent.

Both the growing total and urban population will further intensify pressures on potential Senegalese food grain deficits. As this analysis will show, either greatly increased domestic food grain production or grain imports will be required to feed this expanding population.

B. Current Per Capita Grain Consumption

Table II shows for each of the four regions the current annual per capita consumption of grains. These data have been derived for regions 1 and 2 from previous studies by the author.[10] Other regional consumption estimates are from Senegalese planning documents.[11]

Table II - 1976 Per Capita Consumption of Milled Cereals (KG/year)

	Millet	Rice	Maize	Total
Region 1	60	103	2	165
Region 2	120	35	4	159
Region 3	75	60	15	150
Region 4	95	45	15	155
Country Mean	99.15	51.37	7.46	157.98

These data demonstrate the relative diversity in the composition of the grain diet among the four regions. In urban Dakar, rice is the most important grain; while in rural Senegal, millet still plays a more dominant

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[10] Ross, Clark "Grain Demands and Consumer Preferences, Dakar, Senegal." "A Village Level Study of Producer Grain Transactions in Rural Senegal."

[11] Government of Senegal, Food Investment Strategy, Dakar, Senegal, 1977.

Table III - Elasticity Estimates for the Independent Variables

	Millet				Rice				Maize			
	P_M	P_R	P_C	Y	P_M	P_R	P_C	Y	P_M	P_R	P_C	Y
Region 1	-.92	.123	.092	.97	.029	-.62	.029	1.22	.75	1.33	-.80	.84
Region 2	-.60	.30	.10	.80	.10	-1.1	.05	1.4	.60	1.40	-.60	.80
Region 3	-.50	.20	.10	.70	.10	-.85	.07	1.3	.60	1.50	-.60	.80
Region 4	-.60	.30	.10	.75	.10	-1.2	.05	1.5	.60	1.50	-.60	.80

where P_M, P_R, and P_C are the prices (CFA/kg) for millet, rice, and maize, respectively.
Y is regional per capita income (CFA). Approximately 215 CFA/$ (1979).

role. It should be noted that rural consumption of purchased rice has become increasingly important in Senegal. Specialization in groundnut cultivation has provided cash incomes to farmers who increasingly have been purchasing rice to supplement and to diversify their diet. Rising rural incomes are likely to intensify this tendency.

C. Derivation of Parameters for the Per Capita Demand Equations

As explained in Chapter II, having estimates of the point elasticity at the mean for the independent variables permits the calculation of the coefficients for the independent variables in each equation. Finally, the constant term in each equation can be solved for, knowing all other parameters in the equation. Table III presents the elasticity estimates for each crop in each region. Table IV shows the mean values for the independent variables used in this procedure. Mean values for the dependent variables, the particular regional grain demands are those shown in Table II.

Table IV - Initial Values for the Independent Variables [a]

	P_M	P_R	P_C	Y
Region 1	60	80	60	60,000
Region 2	40	85	40	35,000
Region 3	40	90	40	25,000
Region 4	40	90	40	20,000

[a] Prices are CFA/kg; Income is annual per capita (CFA). Variables are as defined in Table III.

Following the procedure discussed in Chapter II and using the data elements in Tables II-IV, the regional per capita grain demand equations have those parameters shown in Table V. In each equation the annual per capita grain demand is a function of a constant, each grain price, and regional per capita income.

D. Estimation of 1976 Grain Demands

Using the mean per capita consumption figures in Table II in conjunction

Table V - Coefficients of the Per Capita Grain Demand Equations (a's, b's, c's)

Dependent Variable	Millet (KG/Year)					Rice (KG/Year)					Maize (KG/Year)				
Independent Variable	C	P_M	P_R	P_C	Y	C	P_M	P_R	P_C	Y	C	P_M	P_R	P_C	Y
Region 1	42.3	-.92	.092	.092	.001	41	.05	-.8	.05	.002	-2.32	.025	.033	-.027	.00003
Region 2	50.2	-1.8	.42	.3	.0027	18.97	.088	-.45	.044	.0014	-4.76	.06	.066	-.06	.00009
Region 3	39.97	-.94	.167	.19	.002	25.9	.15	-.57	.11	.003	-20	.23	.25	-.23	.0005
Region 4	41.8	-1.43	.32	.24	.0036	24.36	.11	-.6	.056	.0034	-19.5	.23	.25	-.23	.0006

where C is a constant term; all other variables as defined in Table III.

with the regional population estimates for 1976 (Table I) the estimated 1976 Senegalese grain consumption can be derived. Alternatively, using the values of the independent variables shown in Table IV in conjunction with the per capita grain demand equations (Table V) and the population estimates, will yield identical results for the 1976 estimated grain consumption. These estimates are shown in Table VI.

Table VI - Estimated 1976 Regional Grain Consumption (000's Tons)

	Millet	Rice	Maize	Total
Region 1	49.92	85.696	1.664	137.280
Region 2	303.00	88.375	10.10	401.475
Region 3	47.925	38.340	9.585	95.850
Region 4	106.305	50.355	16.785	173.445
National Total	507.150	262.766	38.134	808.050

E. Estimation of 1976 Grain Supply

As explained in Chapter II, Senegal is being partitioned into seven geographic regions to facilitate estimating national agricultural production. Table VII shows, for each of these regions, the base year (1976) surface, yield per hectare, and resulting production for those agricultural products considered in this study.[12] In this part of the analysis production is simplistically defined as surface (ha.) multiplied by yield (kg/ha). After summing the regional productions shown in the column total, a loss factor and a milling yield are applied to each product and the resulting crop disposition is calculated. In the succeeding section these initial crop dispositions will be compared to the 1976 demand estimates, giving an initial grain balance for Senegal.

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[12] Due to the importance of groundnuts as an export earner for Senegal and the direct trade-off between groundnut and grain production, groundnuts have been included in this supply analysis.

Table VII - Agricultural Supply (1976)

Region	Cap Vert	Casam-ance	Diour-bel	Fleuve	Senegal Oriental	Sine Saloum	Thiès	Total	Loss Factor [b]	Milling Yield	Disposable Production
Surface [a] (000 ha)											
Millet	1.5	100	315	74	85	340	165	1080.5			
Maize	0	15	0	5	25	3.5	0	48.5			
Rice	0	65	0	10	5.6	1.7	0.5	82.8			
Groundnuts	2.2	120	320	6	50	500	155	1153.2			
Total	3.7	300	635	95	165.6	845.2	320.5	2365			
Yields [a] (kg/ha)											
Millet	466	850	413	405	588	559	394	510			
Maize	NA	1000	NA	620	800	1000	NA	858			
Rice	NA	1154	NA	1900	1107	529	1000	1227			
Groundnuts	591	1042	731	450	880	880	858	850			
Production (000 tons)											
Millet	.7	85	130	30	50	190	65	550.7	.05	.90	470.9
Maize	0	15	0	3.1	20	3.5	0	41.6	.05	.95	37.5
Rice	0	75	0	19	6.2	.9	.5	101.6	.05	.65	62.7
Groundnuts	1.3	125	234	2.7	44	440	133	980	.10	NA	882.0

Notes: a. The surface and yield estimates are those presented in the Senegalese 1977-1981 development plan.

b. The loss factor includes seed and storage loss. While these estimates are arbitrary and probably too low, the lack of reliable studies of on-farm storage losses precludes more precise estimates.

F. Initial (1976/1977) Senegalese Grain Balance

The results from comparing initial grain demands (Table VI) with the initial domestically produced grain supplies (Table VII) are presented in Table VIII.

Table VIII - Initial Grain Supply/Demand Balance - 1976

	Demand (000T)	Supply (000T)	Difference (000T)[a]	Mean Per Capita Consumption (kg)[b]
Millet	507.150	470.90	-36.250	99.15
Maize	38.134	37.50	-.634	7.46
Rice	262.766	62.70	-200.066	51.37
Total	808.050	571.10	-236.950	157.98

a. A + sign indicates an excess of supply over demand, while a - sign indicates a supply deficit. Any deficit was presumably overcome by imports, food aid, or changes in in-country stocks.

b. A 1976 population of 5,115,000 (Table I) has been assumed.

Certain points emerge from this table. First, domestic grain production in the 1976 reference case only supplies an estimated 71 percent of Senegalese grain consumption.[13] Second, domestic millet production is equivalent to 93 percent of estimated consumption in this base period. Typically, Senegal is nearly self-sufficient in millet production. Millet imports and some sorghum received through donor agencies occasionally supplement domestic production. A shortfall of seven percent, as indicated above, could even be compensated by changes in producer on-farm millet stocks, without resort to commercial imports. As with millet, local maize production is sufficient to satisfy current domestic demand. The relative unimportance of maize in the typical grain diet should be noted. The situation with rice is greatly different. Local rice production accounts for only about twenty-four percent of estimated consumption. Approximately 200,000 tons are annually imported to compensate for this deficit.

From an analysis of those data elements initially used in this modeling of Senegalese grain demand and supply, the dependence on commercial rice imports to satisfy Senegalese grain demands is evident. The relative self-sufficiency in millet and maize has also been shown. The following sections will discuss the sensitivity of Senegalese grain demands and supplies to the critical parameters of the model. This will permit a comparison of demands and supplies under a variety of assumptions.

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[13] While not included in this study, wheat imports, primarily destined for bread, currently average 100,000 tons per year.

Section 2: Sensitivity of Demand Estimates

A. Population

Using those population estimates shown in Table I of this chapter, estimated food grain demands for future years can be generated. The current 4 percent annual growth in the urban population and 1.9 percent growth in the rural population have been applied in this exercise. This results in a compounded annual population growth rate of 2.68 percent between 1976 and 2000. Based on the regional distribution of this population (Table I) and a constant regional per capita ration of each grain (Table II), estimated national grain demands for succeeding years are shown in Table IX.

Table IX - Extension of Current Grain Demands (000's tons)

Year	Population (000)	Millet	Maize	Rice	Total	Percentage Increase of total from 1976
1976	5,115.0	507.15	38.13	262.77	808.05	
1980	5,654.7	558.15	41.81	293.80	893.76	10.6
1985	6,423.9	630.36	46.97	338.65	1,015.98	25.7
1990	7,325.2	714.39	53.03	391.83	1,159.25	43.5
2000	9,660.1	931.27	68.30	531.13	1,530.70	89.4

With the population growth rate assumed and an unchanging regional composition of grain consumption, Senegal's grain demands will sharply increase in succeeding years. By 2000 an 89.4 percent increase from 1976 in total grain consumption is envisioned; this is solely the result of population growth. Since the regional per capita consumption of grains has been held constant, the aggregate grain consumption shown in Table IX only represents 158 kg of grains per capita per annum. Any tendency for this per capita total to increase would further raise the aggregate national demands in any year. Between 1976 and 2000, assuming the current consumption patterns, national millet, maize, and rice demands will increase by 83.6, 79.1, and 102 percent, respectively. The larger growth rate for rice demand results from the assumption that the urban population, with a more rice intensive diet, will grow at a faster rate than the rural population.

The potential severity of this growth in grain demand can best be seen in the perspective of the 1976 base year domestic supply. That supply, covering an estimated 71 percent of total grain demand, was grossly insufficient to satisfy 1976 rice demand; approximately 200,000 tons of rice were imported to offset this deficit. Assuming the same 1976 domestic supply and the 1985 demand estimates, only 56 percent of domestic grain demand estimates, only 56 percent of domestic grain demand would be satisfied by local production.[14] A shortfall of 444,880 tons would result with rice comprising the bulk of this deficit (275,950 tons). While growth in domestic supply should be forthcoming (See the succeeding section on supply), the magnitude of the estimated growth in demand resulting from population increase poses a serious problem to Senegalese policymakers. Changing the composition of grain demands from rice towards millet and maize could succeed in moderating the costly rice imports.[15] It is unlikely that the annual per capita ration of 158 kg can be substantially reduced. Limiting these projected total grain demands requires some diminution in the growth of population.

In fact, with rising incomes the growth of grain demand may be greater than that assumed in this exercise. The sensitivity of these grain demands to income will be discussed in the next sub-section.

B. Income

As formulated in this model, income is an important factor in the estimated grain demand equations. Using the particular income elasticities assumed for each region and grain (Shown in Table III), regional per capita income estimates were raised 10 percent and the grain demands recalculated.[16] This exercise permits an evaluation of the sensitivity of the grain demand to the income estimate chosen. Further, assuming the original income estimates are reasonably accurate, this exercise indicates the likely trend of grain demands with rising incomes.

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[14] A brief review of Senegalese production figures shows little or no growth of domestic grain production during the last 10 years.

[15] The possibility of changing this composition of demand through price policy will be explored in a succeeding sub-section.

With the 10 percent increase in all per capita regional incomes, per capita national grain consumption increased from 157.98 kg/year to 171.5 kg/yr. This 8.56 percent increase suggests a weighted income point elasticity of .856 for national grain demand. This is consistent with those income elasticity estimates shown in Table III where only rice demand was assumed income elastic at the original mean.

Table X presents those national grain demands in 1976 and 1990 calculated with the original income estimate and with the 10 percent increase.

Table X - Sensitivity of Grain Demands to Income Estimate (000 Tons)

	1976				1990			
	Original Demand	+10% Income	Diff.	% Change	Original Demand	+10% Income	Diff.	% Change
Millet	507.1	547.3	40.2	7.9	714.4	771.2	56.8	8.0
Rice	262.7	288.5	25.8	9.8	391.8	427.6	35.8	9.1
Maize	38.1	41.2	3.1	8.1	53.0	57.3	4.3	8.1
Total[a]	807.9	877.0	69.1	8.5	1,159.2	1,256.1	96.9	8.3

[a] Estimated for entire country - Pop. 1976 = 5,115,000
1990 = 7,325,200

The largest percentage increase in demand is for rice. Particularly in rural areas it had been assumed that rice demand was relatively sensitive to income (See Table III). Peasants have a desire to diversify their diet and rice is viewed as a desirable alternative to millet in rural areas. The percentage increase in rice demand is less in 1990 than in 1976 due to the faster growth rate of population assumed for the urban sector whose demand for rice is relatively more income inelastic. In absolute magnitude, millet demand registers the largest increase, an additional 56,800 tons in 1990.

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[16] All other independent variables retain the values shown in Table IV.

If the Senegalese objective of increasing incomes, particularly in rural areas, is achieved, this model shows that national grain demands will be correspondingly affected. The problem of rice imports again must be addressed. With population and income growth combined, projected rice consumption in 1990 would reach 427,600 tons, and increase of 164,900 tons or 63 percent from the estimated 1976 consumption. Without domestic rice production increases or change in the composition of grain consumption, required rice imports would increase from the current 200,066 tons to 364,900 tons. Thus, in projecting future grain demands the effects of increasing incomes must not be ignored.

C. Price Level

The sensitivity of regional and national grain demands to the general grain price level was tested. All grain prices - millet, rice, and maize, were raised 10 percent and the grain demands recalculated. Following this price level increase, estimated national grain demands were only slightly affected. On a per capita basis, the mean annual consumption of all grains only fell by .56 kg from 157.98 to 157.42. The composition of this consumption was only slightly changed, a little more maize (+1.3%) and less millet (-.25%) and less rice (-.8%). This inelasticity of total grain demand with respect to the grain price level can be explained by two factors. First, with the exception of rice in rural areas, own price elasticities had been assumed less than unity. (See Table III) This reflects the relative constancy and importance of grains in the Senegalese diet. Thus, a change in the own price would not greatly modify demand for a particular grain. Second, cross-price responses would tend to raise the demand for each grain as other grain prices were increased. Again, while the magnitude of these responses was assumed low, there would be a tendency to increase consumption of a grain if the prices of the substitute grains were raised. This offsets the tendency for a decrease in demand resulting from an increase in the own price of the grain.

While the actual estimates generated by this exercise are more indicative than definitive, an important policy point is illustrated by the exercise. Public policy aimed at moderately increasing all grain prices would have little effect on aggregate grain demands. Grain represents the least cost means (in terms of calories per monetary unit) for the Senegalese population to sustain itself. Thus, even in the face of price increases for all grains, little change in aggregate grain consumption occurs. This is consistent with the observed purchasing behavior of grain deficit (particularly urban) households. After receiving the monthly salary, the head of the household immediately purchases a sac or other large quantity of rice, insuring that the household's monthly grain needs are met. With this typical behavior, increases in all grain prices would primarily have distributional effects, the incidence of which depends on the actual government policy tool(s) used to change prices. Thus, rice imports would not be significantly decreased by such a policy. Changing the relative prices for grains may be a more effective means to reduce the demand for rice, which is primarily imported, and increase demand for domesticly produced grains. This will be explored in the succeeding sub-section.

D. Relative Grain Prices

For this exercise differing relative grain prices were postulated and the grain demands recalculated. The purpose of this is to assess the extent to which the composition of grain consumption can be influenced by price policy. These results are presented in Tables XI and XII. In Table XI four different sets of relative prices with their implied regional per capita grain consumption and resulting national consumption are shown. Price combination 1 depicts the current situation, using the mean regional grain prices prevailing in 1976. The per capita and national grain demands are those which were originally calculated and previously presented in other tables. Table XII extends the result of this exercise to show projected changes in rice and total grain consumption associated with each price combination in 1976 and 1990. Such changes are calculated from the "base results" generated with price combination 1.

Table XI - Grain Demands and Relative Prices

A. Prices (CFA/kg)

	Price Comb. 1[a]			Price Comb. 2			Price Comb. 3			Price Comb. 4		
	1976 Prevailing Prices			Lowering Millet Price			Raising Rice Price			Raising Rice Lowering Millet (3,4)		
	M	R	C	M	R	C	M	R	C	M	R	C
Region 1	60	80	60	50	80	60	50	120	60	80	120	80
Region 2	40	85	40	30	85	40	40	100	40	40	100	30
Region 3	40	90	40	30	90	30	40	110	40	35	95	40
Region 4	40	90	40	30	90	30	40	110	40	35	95	40

[a] Where M, R, and C are millet, rice, and maize respectively.

B. Per Capita Consumption (kg/year)[a]

	Price Comb. 1				Price Comb.				Price Comb. 3				Price Comb. 4			
	M	R	C	T	M	R	C		M	R	C	T	M	R	C	T
R. 1	60	103	2	165	69	103	2	174	73	71	3	147	47	73	3	123
R. 2	120	35	4	159	138	34	3	175	126	28	5	159	123	28	6	157
R. 3	75	60	15	150	83	57	15	155	78	49	20	147	81	56	15	152
R. 4	95	45	15	155	107	43	15	165	101	33	20	154	104	42	15	161
Weighted Mean[b]	99	51	8	158	113	50	7	170	106	39	10	155	101	42	9	152

[a] Rounded to nearest kg.

[b] Applicable only for 1976 since the regional composition of the projected 1990 population differs slightly from that of 1976.

C. National Demands (tons)

	Millet	Rice	Maize	Total
Price 1 - 1976	507,150	262,766	38,134	808,050
- 1990	714,391	391,827	53,027	1,159,245
Price 2 - 1976	578,363	256,609	36,411	871,383
- 1990	814,914	383,209	50,588	1,248,711
Price 3 - 1976	543,069	197,970	50,314	791,353
- 1990	767,551	293,116	70,094	1,130,761
Price 4 - 1976	518,094	213,379	43,390	774,863
- 1990	725,589	315,057	60,624	1,101,270

Price combination 2, simplistically labeled "lowering millet price" considers the extent to which millet consumption can be raised. Millet consumption increases on a weighted per capita basis (kg) from 99 to 113, or by 14.1 percent. There is, however, only a slight reduction in mean rice and maize consumption. This result is due to the underlying specification of the model where the cross-price response between millet and the other grains was very low, reflecting the belief that the degree of substitutability between millet and rice is quite limited, particularly in urban areas. Consequently, this exercise predicts consumption can be stimulated by a relative price decrease, but not at the expense of other grains, in particular imported rice. The result is simply an increased per capita grain consumption from 158 kg/year to 170 kg/year.

Price combination 3 primarily involves increasing the price of rice in each region. A rather significant decrease in per capita rice consumption results. The weighted mean per capita rice consumption falls from 51 kg/year to 39 kg/year, or by 24 percent. As shown in Table XII such a decrease translates into a significant reduction in national rice consumption and resulting rice imports. In 1990, a reduction of 98,711 tons is predicted by the model. To achieve this reduction, however, the consumer price had to be increased an average of 28 percent with a 50 percent price increase

Table XII - Macro Effects From Changing Relative Prices[a]

(Tons)

	Rice Consumption	Difference	% Diff.	Total Grain	Difference	% Diff.
Comb. 2 - 1976	256,609	-6,157	-2.3	871,383	63,333	+7.8
- 1990	383,209	-8,618	-2.2	1,248,711	89,466	+7.7
Comb. 3 - 1976	197,970	-64,796	-24.7	791,353	-16,197	-2.1
- 1990	293,116	-98,711	-25.2	1,130,761	-28,484	-2.5
Comb. 4 - 1976	213,379	-49,387	-18.8	774,863	-33,187	-4.1
- 1990	315,057	-76,770	-19.6	1,101,270	-57,975	-5.0

[a] The difference for both rice consumption and total grain consumption is calculated by subtracting the projected demand for the indicated price combination from the corresponding demand associated with price combination 1.

in the heavy rice consuming urban Dakar region. The central question posed by this exercise is whether the government of Senegal, in desiring to reduce rice consumption, will have the political will to increase so sharply the consumer rice price. Of interest in this exercise is that total grain consumption was not greatly reduced. The mean consumption of millet and maize increased by 9 kg offsetting 75 percent of the decreased rice consumption.

Price combination 4 sharply raises the rice price but lowers the millet price in regions 3 and 4. The latter was postulated in recognition of the lower than mean grain consumption currently observed in regions 3 and 4. Further, the millet and maize prices were sharply increased in region 1. Again significant savings in projected rice consumption are observed. Total grain consumption in region 1 falls dramatically from 165 to 123 kg/year. Such decreases would represent a 19 percent reduction in national 1976 rice consumption and a 4 percent reduction in total national grain consumption. In this case the brunt of the reduction is borne by the urban Dakar residents (Region 1) and not by the rural residents.

This discussion of relative price changes has shown that policy aimed at changing relative grain prices can succeed in altering the composition, and to a lesser extent the aggregate, of grain consumption. Due to the inelasticity of the postulated own and cross-price elasticities, however, the requisite price changes are quite substantial. It is questionable whether the government of Senegal would or should (from the perspective of equity) increase rice prices to the extent necessary to realize meaningful reductions in rice imports.

E. Own Price Elasticity

Since the elasticities used in this analysis have generally been assumed, rather than derived from actual budget studies, it would be desirable to test the sensitivity of the resulting per capita demands to these elasticity estimates. The own price elasticities assumed for each grain (See Table III and its accompanying discussion) were each increased by 10 percent and the demands recalculated. With these higher own price elasticities, the per capita grain demands would each be somewhat reduced reflecting this greater sensitivity to own price.

These new demands, in comparison with the original reference demands, are shown in Table XIII. The estimated per capita annual grain consumption would fall 11 kg to 147 kg, a decrease of 7 percent. For 1990 this represents a reduction of 83,100 tons of grain, 7 percent of the estimated 1990 consumption. The total reduction in grain consumption can be apportioned among millet (54 percent of total) rice (42 percent) and maize (4 percent).

Thus, while the hypothesized own price elasticities affect the resulting per capita demands, the strength of this effect is not overwhelming. The importance of this is that the aggregate projections of Senegalese grain demands are relatively invariant to reasonable changes in the own price elasticities. Consequently, even if the assumed elasticites were subject to 10 - 20 percent error, the major conclusions from this study of grain demands would still be applicable.

F. Summary of Demand Sensitivity

The major findings regarding the sensitivity of Senegalese grain de-

XIII - Changing Own Price Elasticity

Per Capita (kg/year)	Original Demand				Higher Own - Price Elasticity			
	Millet	Rice	Maize	Total	Millet	Rice	Maize	Total
Region 1	60	103	2	165	55	97	2	154
Region 2	120	35	4	159	113	31	4	148
Region 3	75	60	15	150	71	55	14	140
Region 4	95	45	15	155	89	40	14	143
Weighted Mean[a]	99	51	8	158	93	47	7	147
National Demand (000 tons)								
1976	507.2	262.8	38.1	808.1	475.9	238.5	35.8	750.2
1990	714.4	391.8	53.0	1159.2	669.9	356.5	49.7	1076.1

[a] Applicable only for 1976; that of 1990 would slightly differ.

mands to various parameters are listed below.

1. With a continuation of current population growth and an unchanging composition of per capita grain demands, (158 kg/year total), an 89.4 percent increase in national grain consumption between the years 1976 and 2000 is projected.

2. With the income elasticites assumed, a 10 percent increase in income will increase weighted per capita grain consumption by 8.56 percent from 158 kg/year to 172 kg/year.

3. Increasing all grain prices by 10 percent only reduces per capita grain consumption from 158 kg/year to 157.4 kg/year. This relative inelasticity of total grain consumption with respect to the level of grain prices suggests that a policy to increase uniformly all grain prices would not greatly affect total grain consumption.

4. The composition and, to a lesser extent, the aggregate consumption of grains are both sensitive to changes in relative grain prices. For example, a sharply increased rice price relative to prices for other grains would succeed in significantly reducing total rice consumption.

5. Changing the own-price elasticity by 10 percent in each grain demand equation did not substantially alter the projections of the model.

Section 3 - Sensitivity of Supply Estimates

In this section the sensitivity of domestic production or supply to changes in its independent influences will be explored. The gross domestic production of any crop had been simplistically defined as:

$$S_{i,t} = \sum_{n=1}^{7} \left(\left[Y^{r}_{i,to} \quad (1+g_{i,r})^{t-to} \right] \quad \left[H^{r}_{i,to} \quad (1+h_{i,r})^{t-to} \right] \right)$$

where $S_{i,t}$ = domestic production of crop $\underline{i}$ in time $\underline{t}$

$Y^{r}_{i,to}$ = yield (kg/ha) for crop $\underline{i}$ in time $\underline{to}$ in region $\underline{r}$

$H^{r}_{i,to}$ = base hectarage for crop $\underline{i}$ in time $\underline{to}$ in region $\underline{r}$

$g_{i,r}$ = annual growth rate for yield of crop $\underline{i}$ in region $\underline{r}$

$h_{i,r}$ = annual growth rate for hectarage of crop i in region r

Setting t = to and using the original yield and surface estimates for each crop (Table VII) will provide the original gross domestic production estimates.

Projecting domestic production over time necessitates some assumption about changes in hectarage ($h_{i,r}$) and yields ($g_{i,r}$). Table XIV presents the assumptions used in making the future projections which are then shown in Table XV.

Four different sets of projections have been derived. The first three are labeled autonomous growth, defined to include a continuation of government extension efforts to raise crop yields, no significant reallocation of farmers' resources among crops, and no government or donor capital intensive irrigation projects. For this case, surface growth - a function of population growth and land availability - for each crop in each region is shown in Table XIV under 1. Autonomous Growth-Surface. Three different rates of increase for yields, 0, 2, and 3 percent annually are then postulated. The inherent complexity and incertitude of successfully delivering agricultural extension services to the rural sector require using varying estimates for yield growth. Thus, there are three sets of supply projections listed in Table XV autonomous growth, each associated with a different assumption for yield growth.

The fourth set of supply projections, more ambitious than the previous three, represents those growth rates for surface and yields derived from the current Senegalese plan.[17] These projections include (1) a restructuring of agricultural production towards cereal crops particularly maize and rice, and (2) the beneficial effects (surface and yields) of certain projects for which, neither funding nor the ambitious results can be assured. Also, without a substantial change in the groundnut/millet and groundnut/maize relative prices, as well as, policy action addressing the high domestic resource price for rice, the restructuring of agricultural

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[17] V^{e} Plan Quadriennal de Development Economique et Social 1977-1981. Commission 1 - A (Agriculture), Propositions D'Actions (Juillet 1976) pp. 47-60.

Table XIV Changes in Supply Parameters

(Annual Percentage Increase)

	National Total	Cap Vert	Casamance	Diourbel	Fleuve	Senegal Oriental	Sine-Saloum	Thiès
1. Autonomous Growth								
Surface								
Millet	1.0	.5	1.0	1.0	1.0	1.5	1.0	1.0
Maize	1.2	0	1.5	0	1.0	1.5	1.5	0
Rice	1.0	0	1.25	0	1.0	1.25	.5	0
Groundnuts	1.9	.75	2.0	2.0	1.5	2.0	2.0	2.0
Yields[a]								
2. Government Planned Growth[b] (1976-1981)								
Surface								
Millet	2.0	0	1.0	.6	2.7	2.7	3.7	.9
Maize	12.4	0	10.7	0	19.1	7.0	33.8	0
Rice	8.4	0	2.9	0	30.0	23.6	0	0
Groundnuts	.6	0	3.1	0	0	3.7	.4	0
Yields								
Millet	7.1	1.4	3.0	6.1	4.6	4.5	9.0	9.4
Maize	14.4	0	11.2	0	20.7	12.1	14.9	0
Rice	13.0	0	9.0	0	11.8	20.6	6.9	0
Groundnuts	3.4	1.9	2.9	3.1	5.9	4.2	2.6	3.1

[a] Three uniform annual growth rates (0,2,3) have been tested in this analysis.

[b] Implied annual changes from Government of Senegal planning documents.

production towards cereal crops particularly maize and rice, and (2) the beneficial effects (surface and yields) of certain projects for which, neither funding nor the ambitious results can be assured. Also, without a substantial change in the groundnut/millet and groundnut/maize relative prices, as well as, policy action addressing the high domestic resource price for rice, the restructuring of agricultural production towards cereals crops is unlikely.[18] Further, the yield increases postulated in the

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[18] These two issues are discussed more fully in: CRED, Marketing of Food Crops in the Sahel, University of Michigan, August 1977.

Plan are also of questionable realism. These surface and yield growth rates are shown in Table XIV under part 2.

In any case all four sets of domestic agricultural production projections are presented in Table XV. With each set of projections, the 1976 base figures are again shown to facilitate comparison. Both gross production and disposable production (gross production minus storage, milling, and other post-harvest losses) are shown. Results from each set of projections are briefly reviewed.

With projection 1, the original yields per hectare assumed in Table VII are used in future years (i.e. no improvement in yields assumed). Production increases are solely the result of additional lands being cultivated, in response to population growth. Table XIV provides these annual growth rates on a regional basis. As shown in Table XV during the 1976-1980 period the annual growth in production varies between 1 and 2 percent depending upon the crop. The groundnut production increase is the most substantial reflecting the assumption that a slightly larger proportion of additional lands will be placed into groundnut cultivation than into other crops. At current Senegalese agricultural prices the greater profitability per hectare of groundnut cultivation leads to this land allocation assumption.

Table XVI more clearly demonstrates the impact of no growth in yields per hectare. With population growing at 2.68 percent annually, and total domestic grain production at only 1.07 percent, the per capita production of grains steadily falls from the base (1976) of 111 kg/person to 106 kg (1980) to 90 kg (1990). The assumed base year consumption of 158 kg/person was comprised of 111 kg of domestic production and 47 kg of imported grain. Thus, with this scenario of no yield growth grain imports could increase substantially. Of course, the actual level of imports will depend on the per capita grain demands, the variability of which was previously discussed. In Chapter IV various grain demands and supplies will be compared to estimate the required grain imports. Nevertheless, this supply projection based on no change in yields represents a situation where grain imports would continually increase.

In case 2, yields per hectare are assumed to grow at 2 percent per year, as a result of extension efforts and an increased use of inputs -

Table XV Domestic Production (000 tons)

	1976		1980		1985		1990		2000		Annual Per Cent Increase (Gross)	
1. Yield change[a] = 0	G	D[c]	G	D	G	D	G	D	G	D	1976-1980	1976-1990
Millet	551	471	574	491	605	517	637	545	707	605	1.0	1.04
Maize	42	38	44	40	47	42	51	46	59	53	1.2	1.39
Rice	102	63	106	66	113	70	119	74	135	84	1.0	1.10
Groundnuts	980	882	1067	955	1171	1054	1293	1164	1575	1418	2.0	1.99
Grains-Total[b]	695	572	724	597	765	629	807	665	901	742	1.0	1.07
2. Yield change = .02												
Millet	551	471	622	532	723	618	841	719	1137	972	3.08	3.05
Maize	42	38	48	43	57	51	67	61	95	86	3.39	3.37
Rice	102	63	115	71	135	84	158	98	216	133	3.04	3.16
Groundnuts	980	882	1148	1033	1399	1259	1705	1535	2533	2280	4.03	4.01
Grains-Total	695	572	785	646	915	753	1066	878	1448	1191	3.09	3.08
3. Yield change = .03												
Millet	551	471	647	553	789	675	964	824	1438	1229	4.10	4.05
Maize	42	38	50	45	62	56	77	70	120	108	4.46	4.40
Rice	102	63	119	74	147	91	181	112	274	169	3.90	4.16
Groundnuts	980	882	1194	1075	1528	1375	1955	1760	3202	2882	5.00	5.03
Grains-Total	695	572	816	672	998	822	1222	1006	1832	1506	4.00	4.09
4. Government Projections												
Millet	551	471	782	669							9.15	
Maize	42	38	108	98							26.60	
Rice	102	63	234	145							23.10	
Groundnuts	980	882	1132	1019							3.70	
Grains-Total	695	572	1124	912							12.80	

where: G = gross total production, D = disposable production after milling, storage, and other losses.

[a] Yield change = an annual percentage change in yields per hectare.

[b] Grains total is the sum of millet, maize, and rice.

[c] Milling and loss factors are those shown in Table VII.

Table XVI Key Production Indicators

		1980[a]				1985[a]				1990[a]				2000[a]			
Yields (kg/ha)	1976	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Millet	510	510	552	574	669	510	610	666	--	510	673	771	--	510	820	1037	--
Maize	858	858	929	966	1411	858	1025	1120	--	858	1132	1298	--	858	1380	1744	--
Rice	1227	1227	1328	1328	2044	1227	1466	1601	--	1227	1618	1855	--	1227	1973	2495	--
Groundnuts	850	850	920	957	956	850	1016	1109	--	850	1121	1286	--	850	1367	1728	--
Net Per Capita Production (kg)																	
Millet	92	87	94	98	118	81	96	105	--	74	98	113	--	63	101	127	--
Maize	7	7	8	8	17	7	8	9	--	6	8	10	--	6	9	11	--
Rice	12	12	13	13	26	11	13	14	--	10	13	15	--	9	14	18	--
Grains	111	106	115	119	161	99	117	128	--	90	119	138	--	78	124	156	--
Groundnuts	172	169	183	190	180	164	196	214	--	159	210	240	--	147	236	298	--
Population (000's)	5115	5655				6424				7325				9660			

a/ 1. Yield change = 0; surface change in Table XIV
2. Yield change = 2%/year; surface change in Table XIV
3. Yield change = 3%/year; surface change in Table XIV
4. Yield and surface changes planned by government (Table XIV)

animal traction, seeders, pesticides, and fertilizer. As shown in Table XVI the per hectare yields in the year 2000 range from 820 kg for millet to 1973 kg for rice. Since the increase in total grain production, 3.08 percent per year, slightly exceeds estimated population growth, per capita domestic grain production increases from 111 kg (1976) to 115 kg (1980), 117 kg (1985), and 124 kg (2000).[19] Again, per capita production does not approach the estimated reference year (1976) consumption of 158 kg/person.

Finally in case 3, a more ambitious yield increase - 3 percent per annum - was assumed. The resulting 4.09 percent growth (1976-1990) in domestic production raises per capita production to 115 kg in 1980 and to a high of 156 in 2000. Assuming no variation in per capita consumption, domestic grain supply would roughly equal the initial per capita consumption by the year 2000. A major problem, however, is the composition of this projected year 2000 domestic supply - 81 percent millet, 7 percent maize, 12 percent rice. In comparison, the 1976 per capita consumption was comprised of 62 percent millet, 6 percent maize, and 32 percent rice. A per capita consumption decrease from 51 kg to 18 kg of rice would be needed to equilibrate the original demand with the projected supply in the year 2000. Since per capita rice consumption has actually been increasing, such a sharp decrease is most unlikely without a sharply increased rice price. This topic will be explored more fully in the following chapter.

It should be emphasized that even with this postulated, sustained 3 percent annual growth in yields, domestic per capita grain production would barely provide sufficient grain to meet assumed nutritional requirements by 2000. Further, the composition of that domestic supply would require a marked change in the grain consumption patterns of the Senegalese population.

Finally, scenario 4 uses government planned growth rates for surface and yields. As shown in Table XIV, such projections, made for the 1976-1981 Five Year Plan, are considerably more ambitious than those postulated in scenaria 1 - 3. While the requisite programs and projects to achieve such growth rates are referenced in the Five Year Plan, it is highly unlikely that such striking results could be achieved. Nevertheless, scenario 4 presents the projected 1980-81 domestic grain supply using these growth rates.[20] By 1981 the per capita domestic supply of all grains is estimated at 161 kg/capita, slightly in excess of the 158 kg/capita initial demand. Again, however, the incompatability between the composition of demand and supply must be examined. Per capita rice production would be 26 kg/capita compared to a current consumption estimated at 51 kg/capita. Thus, there are two major problems with these government projections: (1) their feasibility and (2) the unacceptable composition of this grain supply.

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[19] The 3.08 growth represents the compounded and combined effects of surface and yield increases.

This section has given some simplistic projections of per capita grain supply; the assumptions for yield per hectare and surface growth differentiate the various supply scenaria. In summary this chapter has derived the initial demand and supply functions for this model and evaluated the sensitivity of these functions to their various independent influences. Chapter IV will compare demand and supply projections under a variety of these assumptions. The resulting grain imbalances with their implied imports and/or surpluses will be noted.

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[20] This exercise was done only until 1980-81, the time frame of the Plan. Continuing with such annual growth rates until 1985 provides production estimates well beyond Senegalese capabilities or needs.

CHAPTER IV

Those demand and supply projections generated in Chapter III will now be integrated to provide estimated Senegalese grain balances for selected future years. Section 1 will simply project a continuation of current trends in supply and demand predicted from the model of Senegalese agriculture described in Chapters II and III. In Section 2 the sensitivity of the grain balances to the changes in the model's parameters discussed in Chapter III will be assessed.

Section 1 - Grain Balances With Original Parameters

In this section predictions of future grain demands and supplies based on the original demand parameters of the model will be made. Specifically, the coefficients for the independent variables in the demand equations are those shown in Table V, corresponding to the elasticity estimates of Table III. Values for the independent variables, grain prices and income, are also those previously used in the model and detailed in Table IV. The resulting, per capita regional demands, will be identical to those shown in Table II.

In essence, with no change in either the values of the independent variables or the consumer responses (elasticities) to these variables, grain demands only change as a result of national population growth and the shift in the rural-urban composition of population. The urban population is growing more rapidly than the rural population and a changing national mean per capita demand over time reflects this differential growth. Specifically, rice accounts for a slightly increasing proportion of total grain consumption.

Domestic supply projections are those shown in Table XV, including three assumed rates of productivity change and finally targeted government production for 1980. The disposable production, after deduction for seed, storage and processing losses, is used in calculating the grain balances. These balances, both on a national and per capita basis are shown in Table XVII.

In the base year, 1976, required grain imports were 236,950 tons, of which 200,066 tons were rice. Approximately 29 percent of grain consumption, or, on a per capita basis, 46 kg of the mean 158 kg annual consumption, was satisfied by commercial imports.

Table XVII-A - Grain Demand, Supply, and Balance

Year 1980 Population 5,654,700

		Supply				Balance - Demand With[c,d]			
	Demand	S-1	S-2	S-3	S-4	S-1	S-2	S-3	S-4
Millet									
National[a]	558.2	491	532	553	669	-67.2	-26.2	-5.2	+110.8
Per Capita[b]	98.7	86.8	94.1	97.8	118.3	-11.9	- 4.6	- .9	+19.6
Rice									
National	293.8	66	71	74	98	-227.8	-222.8	-219.8	-195.8
Per Capita	52.0	11.7	12.6	13.1	17.3	-40.3	-39.4	-38.9	-34.6
Maize									
National	41.8	40	43	45	145	-1.8	+ 1.2	+3.2	+103.2
Per Capita	7.4	7.1	7.6	8.0	25.6	- .3	+ .2	+ .6	+ 18.3
Total									
National	893.8	597	646	672	912	-296.8	-247.8	-221.8	+ 18.2
Per Capita	158.1	105.6	114.2	118.9	161.3	- 52.5	- 43.8	- 39.2	+ 3.2

[a] 000's tons/year

[b] kg/year

[c] (-) deficit (+) surplus

[d] possible rounding error

Table XVII-B - Grain Demand, Supply, and Balance

Year 1985 Population 6,423,900

		Supply			Balance - Demand With[c,d]		
	Demand	S-1	S-2	S-3	S-1	S-2	S-3
Millet							
National[a]	630.4	517	618	675	-113.4	-12.4	+44.6
Per Capita[b]	98.1	80.5	96.2	105.1	-17.7	-1.9	+6.9
Rice							
National	338.7	70	84	91	-268.7	-254.7	-247.7
Per Capita	52.7	10.9	13.1	14.2	-41.8	-39.7	-38.6
Maize							
National	47.0	42	51	56	-5	+4	+9
Per Capita	7.3	6.5	7.9	8.7	- .8	+ .6	+1.4
Total							
National	1016.1	629	753	822	-387.1	-263.1	-194.1
Per Capita	158.1	97.9	117.2	128	-60.3	-41.0	- 30.2

[a] 000's tons/year

[b] kg/year

[c] (-) deficit, (+) surplus

[d] possible rounding error

Table XVII- C - Grain Demand, Supply, and Balance

Year 1990 Population 7,325,200

		Supply			Balance - Demand With[c,d]		
	Demand	S-1	S-2	S-3	S-1	S-2	S-3
Millet							
National[a]	714.4	545	719	824	-169.4	+4.6	+109.6
Per Capita[b]	97.5	74.4	98.2	112.5	-23.1	+ .7	+15.0
Rice							
National	391.8	74	98	112	-317.8	-293.8	-279.8
Per Capita	53.5	10.1	13.4	15.3	-43.4	- 40.1	-38.2
Maize							
National	53	46	61	70	-7	+8	+ 17
Per Capita	7.2	6.3	8.3	9.6	- .9	+1.1	+2.3
Total							
National	1159.2	665	878	1006	-494.2	-281.2	-153.2
Per Capita	158.2	90.8	119.9	137.4	- 67.4	-38.3	- 20.9

[a] 000's tons/year

[b] kg/year

[c] (-) deficit, (+) surplus

[d] possible rounding error

Table XVII-D - Grain Demand, Supply, and Balance

Year 2000 Population 9,660.1

		Supply			Balance - Demand With[c,d]		
	Demand	S-1	S-2	S-3	S-1	S-2	S-3
Millet							
National[a]	931.3	605	972	1229	-326.3	+40.7	+297.7
Per Capita[b]	96.4	62.6	100.6	127.2	-33.8	+4.2	+30.8
Rice							
National	531.1	84	133	169	-447.1	-398.1	-362.1
Per Capita	55.0	8.7	13.8	17.5	-46.3	-41.2	-37.5
Maize							
National	68.3	53	86	108	-15.3	+17.7	+39.7
Per Capita	7.1	5.5	8.9	11.2	- 1.6	+ 1.8	+ 4.1
Total							
National	1530.7	742	1191	1506	-788.7	-339.7	-24.7
Per Capita	158.5	76.8	123.3	155.9	-81.7	-35.2	- 2.6

[a] 000's tons/year

[b] kg/year

[c] (-) deficit, (+) surplus

[d] possible rounding error

A. 1980

By way of comparison, the 1980 grain balance shown in Table XVII-A indicates that the grain deficit could become more severe. Using S-1 and S-2, with a 0 and 2 percent annual change in yields per hectare respectively, both the rice and total grain deficit increases. Moreover there would be a need to import millet to equilibrate domestic millet demand and supply. With S-3 and the associated 3 percent annual growth in yields the total deficit falls to 221,800 tons or 39 kg per capita. Nevertheless, even with S-3 the rice deficit continues to be substantial, 219,800 tons.

The government targets for domestic production are sufficient to eliminate the grain deficit by 1980; in fact a small surplus of 18,200 tons could conceivably be generated. Two major qualifications must be addressed. First, the 12.8 percent annual growth of grain production implied by the government targets is unduly optimistic. The major supporting programs needed for such annual growth are neither organized nor funded. While existing efforts at rural development should succeed in increasing production, a more modest annual growth of 2 or 3 percent (S-2 or S-3) would seem appropriate. It is inconceivable to expect the rapid growth projected by the government in such a short time period.

Second, even if the government targets were reached, serious imbalances in the composition of grain production would result. Using current grain prices the per capita demands for millet and maize would be greatly below the corresponding per capita supplies. In contrast, per capita rice demand (52 kg) would be greatly superior to per capita production (17.3 kg). An excess per capita rice demand of 34.7 kg would presumably exist. Since these three grains are not perfect substitutes, the government would have to initiate some taxing/subsidy scheme to change relative grain prices so that particular grain demands and supplies could be equilibrated. Failing to do that, millet and maize prices would fall dramatically and the rice price would increase drastically. It is highly unlikely however, that farmers would produce the quantities of millet and maize envisioned by the government if producer prices for these grains fell so sharply. With groundnut cultivation as a more profitable alternative, it is even questionable if farmers would produce the projected quantities of millet and maize at current prices.

Specifically, using the grain demand equations it is possible to solve for those consumer grain prices which equilibrate national demand and the projected government supply. For the Cap Vert area the generated consumer prices are 32.55 CFA/kg (current price 60 CFA/kg) for millet, 123.19 CFA/kg (current price 80 CFA/kg) for rice, and - 82.86 CFA/kg (current price 60 CFA/kg) for maize.[21] In brief, to induce an annual per capita millet consumption of 118.3 kg the millet price in region 1 would have to fall from 60 CFA/kg to 32.55 CFA/kg. This would imply a producer price of 5-10 CFA/kg, much too low to generate any millet production destined for sale. Another possibility would be for the government to subsidize millet production; however, the subsidy expense would be at least (60-32.55 CFA/kg) x (1000 kg/ton) x (167,250 tons) or $21,353,547 at 215 CFA/$. For this exercise only 25 percent of the 669,000 ton millet crop is assumed marketed.

Additionally, to reduce per capita rice consumption to 17.3 kg from the projected 52.0 kg, the consumer rice price must rise 54 percent from 80 CFA/kg to 123.19 CFA/kg. Again, the government would be faced with a difficult problem. The equity effects of this pricing decision, implemented by tax or tariff, would be unfavorable to low income urban consumers who currently depend on rice for a major share of their daily grain intake.[22] To induce the projected 25.6 kg per capita maize consumption, the system of grain demand equations indicates a negative price. While such a price has little economic significance, it demonstrates the relatively inflexible maize demand which currently exists in Senegal.

The conclusion of this discussion is that a very distorting and expensive price policy would be needed to encourage consumers to adopt the per capita consumption levels associated with the government's grain supply targets. Also, it should not be forgotten that these supply targets themselves are unrealistically high.

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[21] Regional price differentials for each grain are those indicated in Table IV; i.e. intermediate marketing expenses and margins were assumed unchanged.

[22] Of course, imports could be permitted and the equilibrium rice price would fall in relation to the magnitude of these imports. The government supply targets, with 161.3 kg of total grain consumption, however, assumed self-sufficiency, i.e. no imports.

B. 1985

For 1985 only the three supply scenaria with autonomous yield growth of 0, 2, and 3 percent are shown. The government planned targets with their 12.8 percent annual growth in total grain production are not continued beyond 1981. With respect to 1980, S-3 represents an improvement on a per capita basis. The annual grain deficit would fall from 39.2 kg to 30.2 kg per capita with S-3. Slight surpluses in millet and maize would compensate for a continually substantial rice deficit in S-3. With S-1, population growth exceeds the growth of grain production and the annual per capita deficit is 60.3 kg. With S-2, growth in domestic grain production slightly exceeds the growth of population.

C. 1990 and 2000

While projections into 1990 and 2000 are rather risky, this analysis indicates that with S-3 the per capita deficit could fall to 20.9 kg in 1990 and 2.6 kg in 2000. The two criticisms directed against the 1980 government projections are relevant to this case. First, achieving near food self-sufficiency in 2000 (2.6 kg per capita deficit) requires annual yield growth of 3 percent for 24 years; i.e. 2000 yields must increase by 103 percent from those of 1976. It is not clear that such continual increases are possible in light of the potential land degradation from the intensive use of agricultural lands projected for Senegal. Second, the composition of the domestic grain supply will differ greatly from the composition of domestic demand. In principle, millet and maize surpluses would roughly compensate for rice deficits. As shown in the previous section, unless a price policy with subsidies and/or taxes were used, the projected millet and maize production will not be forthcoming, since the producer prices for these grains would fall to very low levels.

With S-1 both the per capita and the total grain deficit will increase substantially reaching 81.7 kg and 788,700 tons by 2000. With S-2 some reduction in the per capita deficit is projected between 1990 and 2000 but the total grain deficit would increase from 281,200 tons to 339,700 tons.

D. Summary

Certain points warrant review. First, without any improvement in domestic production, as in the case of S-1, locally grown grains would account for only 48 percent of projected 2000 demand, as compared to 71 percent in 1976. Second, even with a continual 2 percent annual growth in yields per hectare, as premised in S-2, the per capita domestic production only increases from 112 kg (1976) to 123 kg in 2000. Because of population growth, the magnitude of the national deficit increases. Third, annual yield growth of 3 percent is required to achieve local grain production in the year 2000 that is roughly of the same magnitude as projected demand. Such sustained growth will require major commitment of funds and efforts to the rural sector. Finally, the composition of grain demand, a substantial portion of which is rice, will not be well harmonized with the projected composition of domestic supply. Large millet and maize surpluses and rice deficits will result.

As previously discussed a distorting subsidy/tax policy will be required to equilibrate the individual grain demands and supplies.

The succeeding section of this chapter will examine the sensitivity of the derived grain balances to the underlying demand parameters. In Chapter V various strategies to assure adequate grain supplies for Senegal will be discussed.

Section 2 - Sensitivity of Grain Balances to Demand Assumptions

In this section the sensitivity of the derived grain balances to changes in the demand parameters will be assessed.

A. Income

Using those income elasticities posited in Table III, the per capita and national grain demands were re-estimated on the assumption that the 1990 per capita income would be 10 percent higher than that of 1976. These estimated demands were shown in Table X; the corresponding grain balances for these estimates are now shown in Table XVIII.[23]

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[23] Only those balances associated with S-1 (0 percent change in yields) and S-3 (3 percent annual change in yields) are shown. Balances for S-2 would lie between those projected for S-1 and S-3.

As expected, the increased grain demands associated with a higher income level imply large projected grain deficits. In fact, with S-1 only 47 percent (80.5/171.5 kg - See Table X) of projected grain consumption would be satisfied by local production.

This discussion demonstrates a fundamental problem which the Senegalese government must face. Increasing incomes is a stated policy goal as well as increasing food self-sufficiency. Yet, even with a modest rise in income (10 percent) and relatively low income elasticities (Table III) the increase in the grain deficit is quite substantial. This results because every kg of additional demand represents an additional kg of grain deficit. For instance, the projected rice deficits increase by 35,800 or by 11 and

Table XVIII 1990 Grain Balances With Income Increase

	Original (Table XVII)		10% Income Increase	
	S-1	S-3	S-1	S-3
Millet				
National (000 tons)	-169.4	+109.6	-226.2	+52.8
Per Capita (kg)	-23.1	+15.0	-30.8	+7.2
Rice				
National	-317.8	-279.8	-353.6	-315.6
Per Capita	-43.4	-38.2	-48.2	-43.1
Maize				
National	-7	+17	-11.3	+12.7
Per Capita	-.9	+2.3	-1.5	+1.7
Total Grain				
National	-494.2	-153.2	-591.1	-250.1
Per Capita	-67.4	-20.9	-80.5	-34.2

13 percent under S-1 and S-3 respectively. This itself represents an additional $7.16 million of grain imports. Thus, in designing grain policy the government must be aware of potential grain demand increases stimulated by other policy actions aimed at raising rural and urban incomes.

B. Price Elasticity

In Chapter III the sensitivity of the per capita demand estimates to a 10 percent increase in the assumed own price elasticities was assessed.[24] These recalculated demands are now used with S-1 and S-3 to generate grain balances under the assumption of a greater sensitivity of grain demands to own price. Table XIX presents these results for 1990.

Table XIX - 1990 Grain Balances With Higher Own Price Elasticity

	Original (Table XVII)		10% Elasticity Increase	
	S-1	S-3	S-1	S-3
Millet				
National (000 tons)	-169.4	+109.6	-124.9	+154.1
Per Capita (kg)	-23.1	+15.0	-17.1	+21.0
Rice				
National	-317.8	-279.8	-282.5	-244.5
Per Capita	-43.4	-38.2	-38.6	-33.4
Maize				
National	-7	+17	-3.7	+20.3
Per Capita	-.9	+2.3	.5	+2.8
Total				
National	-494.2	-153.2	-411.1	-70.1
Per Capita	-67.4	-20.9	-56.2	-9.6

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[24] Since the own price elasticites used in the original demand equations were not all derived from budget studies, it was deemed important to assess the sensitivity of the demand estimate to these elasticities.

If in fact the true own price elasticities are higher than those used in the original model, the projected national grain deficit in 1990 would be less than originally estimated. Nevertheless, the rice deficit continues to be substantial still above 244,000 tons under the most optimistic supply assumption (S-3). Total local grain production under S-3 combined with these decreased demands would satisfy about 93 percent of total grain demand. The problems previously discussed -- (1) the necessity for a compensating price policy to encourage millet and maize consumption and (2) the imbalance between supply and demand for rice -- would have to be confronted with government action before this could be considered a realistic scenario.

While this particular exercise has shown that the actual grain balance is sensitive to the own price elasticity estimate, the two fundamental conclusions emanating from the original derivation of the grain balances are still valid. First, without impressive and sustained growth in the agricultural sector -- with growth in grain production at least surpassing the 2.68 percent annual increase in population -- the total Senegalese grain deficit will continue to increase. Only the ambitious growth assumed in S-3 leads the country towards a domestic grain production sufficient to cover national needs. Second, all combinations of demand and supply indicate a serious and chronic rice deficit. For example, under S-1 and a lower own price elasticity, that rice deficit is projected at 317,800 tons in 1990; under a very optimistic set of assumptions -- S-3 and higher own price elasticities -- the national rice deficit would be 244,500 tons in 1990. Thus, even considering the most pessimistic and most optimistic set of assumptions, a continually increasing rice deficit is projected.

C. Grain Price Level

When all grain prices were raised 10 percent the per capita total grain demand changed by less than one percent. The composition of this new demand was slightly altered, a little more maize (+.3 percent) and less millet (-2.5 percent) and less rice (-.8 percent).

The reason for this relative insensitivity of total grain demand to the grain price level is found in the nature of the demand equations.

Since each particular grain demand is a function of all grain prices, cross-price responses would tend to raise the demand for each grain as other grain prices were increased. This gain, of course, is offset to varying degrees by the decrease in demand from an increase in the own price of the grain.

Consequently, since the resulting grain balances would be little changed from those shown in Section 1 of this chapter, they are not repeated here. The main conclusion is that proportionately changing the price of all grains will do little to affect grain demand and the resulting grain balances. As will be discussed in Chapter V, changing relative grain prices is a more effective, and perhaps necessary, action to equilibrate individual grain demands and supplies.

D. Summary

Section 2 has shown that the main conclusions concerning grain balances derived from Section 1 of this chapter are still relevant when changing demand conditions are assumed. Substantial grain deficits, except in the year 2000 with S-3, will plague Senegal under all combinations of demand and supply considered. The annual rice deficit will continue to be substantial even under those conditions where the total grain deficit is mitigated. In those cases, millet and maize surpluses are present and some policy action to restructure demand will be necessary.

With rising incomes all deficits are proportionately increased. Since raising personal incomes is also a policy goal of the Senegalese, this effect should be considered in any policy proposal. A change in the own price elasticity, such that demands are more sensitive to own grain prices, somewhat reduces the total grain deficit. Annual per capita consumption of grains, however, falls from 158 to 147 kg. Also, the rice deficit continues to exceed 244,000 tons in 1990. This section has shown that the fundamental imbalances in Senegalese grain consumption are relatively invariant to reasonable changes in the demand assumptions.

CHAPTER V - TOWARDS A GRAIN POLICY FOR SENEGAL

This chapter will discuss the principal grain policy options available to the Government of Senegal. Each option will be evaluated in the context of the grain balances derived in Chapter IV. The first section considers a continuation of current trends - a continual grain deficit with substantial imports of rice. Section 2 analyzes the possibility of using price policy to equilibrate demand with domestic supply. Finally, in section 3, major supply initiatives, like the construction of irrigation dams, will be considered.

Section 1 - A Continuation of Grain Imports

As discussed in earlier chapters, a possible means for Senegal to insure adequate grain supplies would be through a continuation of rice imports. Such a strategy, however, would be at variance with Senegal's professed goal of food self-sufficiency. Nevertheless, this strategy is explored here for a number of reasons. First, at a foreseeable range of current world prices for groundnuts and rice, Senegal has a static comparative advantage in groundnut production. Resulting imports of rice would be financed from groundnut export earnings.[25] Second, without a restructuring of domestic agricultural prices and/or major supply initiatives (construction of large irrigation facilities) continued rice imports are inevitable, as shown by the various supply-demand projections in Chapters III and IV. Finally, policymakers can benefit from this projection of the current situation, providing a reference to which other strategies can be compared. For these reasons, an evaluation of continued rice imports is necessary.

For this exercise the initial regional supply parameters - surface, yields per hectare, and production - shown in Table VII of Chapter III are used. For ensuing years changes in surface and per hectare yields are those shown in Table XIV. Finally, in Table XV the resulting domestic production for key years - 1976, 1980, 1985, 1990, and 2000 is shown. These production estimates are considered as domestic supply for the indicated year and used with domestic demand estimates to provide the projected grain balances.

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[25] Jabara, Cathy, "Agricultural Comparative Advantage Under Uncertainty, The Case of Senegal" Unpublished Ph.D. Thesis, Purdue University, May 1979.

Of the four supply scenaria depicted in Table XV the first three are premised on no relative change in the allocation of land and labor among the principal crops. These scenaria are differentiated by varying annual growth rates for yields per hectare (0, 2, 3 percent/annum). Scenario 4, based on Senegal's enunciated National Development Plan, foresees a relative reallocation of production resources from groundnuts to domestic grain crops. In the absence of an effective price policy, it is unclear how the proposed reallocation of resources would be achieved. Also, the government projections are based on yield increases averaging 10 percent/annum for the grain crops. Again, without major commitments of resources and funding, it is unlikely that such yield increases can be achieved.

The national grain demands used in this exercise are those shown in Table IX of Chapter III. They assume a continuation of the current regional per capita ration of grain. In 1976 the national mean was 158 kg/capita, of which 99 kg was millet, 8 kg was maize, and 51 kg was rice. Increased grain demand is solely a function of population growth in this calculation. These are the demand estimates used to calculate the grain balances in section 1 of Chapter IV. (See Tables XVII A - D).

Projected balance of trade accounts using the previously mentioned grain balances are now presented in Table XX.

As Table XX indicates the base year trade surplus of $396,710 is increased under all supply-demand scenaria. Even though required rice imports increase steadily, the growing cost of these imports is more than offset by augmented groundnut production and export receipts. Thus, it is again appropriate to question the wisdom in deviating from a strategy of comparative advantage to one of grain self-sufficiency. Certain qualifications to this analysis do indicate, however, possible reasons for increased domestic production of grains.[26]

(1) The world prices used in this analysis are subject to fluctuation, particularly adverse ones to Senegal. While the argument of world price risk has economic validity, within a foreseeable range of world prices (groundnuts $350 - 650/ton and rice $150 - 350/ton) the strategy of ex-

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[26] An excellent discussion of this issue can be found in Jabara, Cathy, op. cit.

Table XX - Balance of Trade[a]

(000 tons, 000$)

		Groundnuts	Millet	Rice	Maize	Total
1976	tons	+882	-36.25	-200.1	+.634	-
	$	+441,000	-4,350	-40,020	80	+396,710
1980	S-1 - tons	+955	-67.2	-227.8	-1.8	-
	$	+477,500	-8,060	-45,560	-200	+423,680
	S-2 - tons	+1,033	-26.2	-222.8	+1.2	-
	$	+516,500	-3,140	-44,560	+160	+468,960
	S-3 - tons	+1,075	-5.2	-219.8	+3.2	-
	$	+537,500	-620	-43,960	+420	+493,340
	S-4[b]- tons	+1,019	+110.8	-195.8	+103.2	-
	$	+509,500	+13,296	-39,416	+13,416	+497,052
1990	S-1 - tons	+1,164	-169.4	-317.8	-7	-
	$	+582,000	-20,300	-63,560	-910	+497,230
	S-2 - tons	+1,535	+4.6	-293.8	+8	-
	$	+767,500	+550	-58,760	+1,040	+710,330
	S-3 - tons	+1,760	+109.6	-279.8	+17	-
	$	+880,000	+13,150	-55,960	+2,200	+839,390
2000	S-1 - tons	+1,418	-326.3	-447.1	-15.3	-
	$	+709,000	-39,200	-89,400	-1,990	+578,410
	S-2 - tons	+2,280	+40.7	-398.1	+17.7	-
	$	+1,140,000	+4,880	-79,620	+2,300	+1,067,560
	S-3 - tons	+2,882	+297.7	-362.1	+39.7	-
	$	+1,441,000	+35,700	-72,420	+5,160	+1,409,440

[a] (1) World Prices/Ton:
Groundnuts - $500
Millet - $120
Rice - $200
Maize - $130
(2) (+) export, (-) import

[b] Government planned projections are only for 1980.

changing groundnuts for rice on the world market is still economically advantageous.

(2) The assumption that 90 percent of the groundnut crop is exported is unrealistic. Considering local groundnut consumption, 90 percent of the recorded crop is not available for export. However, in assessing the potential or economic value of the groundnut crop, the 90 percent estimate is justifiable. Second, a large portion of the groundnut crop is transformed to groundnut oil and exported at a value exceeding the $500/ton for unprocessed groundnuts used in this calculation. Thus, the projected groundnut export receipts are not grossly overestimated.

(3) The import requirements for various crops have not been considered in the calculation. Currently, fertilizer, theoretically needed for all crops, is the major import for the agricultural sector. It could be argued that the import requirements for increased domestic rice and grain crops would exceed their analogues in groundnut production. This is particularly true if large scale irrigation projects, with heavy capital requirements, are introduced.

(4) The analysis has assumed that an export market for the millet and maize surpluses projected in S-2 and S-3 exists. Two of Senegal's neighbors, The Gambia and Mauritania, have chronic food deficits and would probably be willing to import surplus Senegalese grains. Also, the relatively small surpluses with S-2 may be eliminated by market induced declines in the consumer millet and maize prices. It is unlikely, however, that the projected surpluses in S-3 can be eliminated by declines in consumer prices. The requisite consumer millet and maize prices to equilibrate supply and domestic demand would imply a producer price too low to stimulate the projected production. Thus, without export markets for millet and maize their production would decline as resources were transferred into groundnuts. This would actually increase the projected trade surplus as the higher value groundnut crop would be expanded.[27]

Even with the above qualifications a continued emphasis on groundnut production with the resulting rice imports appears to be advantageous to

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[27] In fact, at current producer prices it is unlikely that any maize or millet surplus would exist as producers would quickly respond, within one agricultural season, and produce additional groundnuts.

Senegal. Under all supply scenaria tested, potential groundnut export earnings greatly exceed the expense associated with continued rice imports. A second advantage to continued rice imports is that consumer preferences, with their strong attachment to rice, can be satisfied. The strategy of food self-sufficiency with a heavy reliance on increased millet and maize production implies a major change in consumer grain consumption. Without a distorting and expensive governmental price policy, a shift in the composition of consumer grain consumption will not be forthcoming.

Having assessed the macro-economic effects from a continuation of rice imports as a means to insure adequate grain supplies, the use of price policy to shift grain demand from rice to millet and maize will now be considered.

Section 2 - Price Policy

The section assesses the potential to use price policy to shift national grain consumption from rice to increased millet and maize consumption. Domestic production of millet and maize can be more easily and less expensively increased than domestic rice production. Increased consumer acceptance of millet and maize must accompany the supply increases of these grains. A possible way to stimulate millet and maize consumption would be a price policy lowering the consumer prices for these grains and raising the consumer rice price. Examples of such price policies will be evaluated in this section.

In Table XI of Chapter III per capita grain demands associated with four sets of relative grain prices were derived. Price combination 1 represented the existing relative prices for grains and the per capita demands were those used in the reference year calculations shown throughout this study. Price combinations 2, 3, and 4 were simplistically described as (2) lowering the millet price, (3) raising the rice price, and (4) simultaneously raising the rice and lowering the millet prices. The actual prices used in the exercise, as well as the associated regional per capita grain demands, are shown in Table XI.

Table XXI presents estimates of 1990 national grain demand, the per capita equivalents, and the projected grain balances using both S-1 (no change in per hectare yields) and S-3 (annual growth of 3 percent from 1976 base yields). The regional grain prices are also shown with each

Table XXI - Effects of Price Policy

Grain	Price Comb. 1			Price Comb. 2			Price Comb. 3			Price Comb. 4		
	PC (kg)	ND (000 tons)	Balance (000 tons)	PC	ND	Balance	PC	ND	Balance	PC	ND	Balance
Consumption												
With S-1												
Millet	99	714.4	-169.4	113	814.9	-269.9	106	767.6	-222.6	101	725.6	-180.6
Rice	51	391.8	-317.8	50	383.2	-309.2	39	293.1	-219.1	42	315.1	-241.1
Maize	8	53.0	-7.0	7	50.6	-4.6	10	70.1	-24.1	9	60.6	-14.6
Total	158	1159.2	-494.2	170	1248.7	-583.7	155	1130.8	-465.8	152	1101.3	-436.3
With S-3												
Millet	99	714.4	+109.6	113	814.9	+9.1	106	767.6	+56.4	101	725.6	+98.4
Rice	51	391.8	-279.8	50	383.2	-271.2	39	293.1	-181.1	42	315.1	-203.1
Maize	8	53.0	+17.0	7	50.6	+19.4	10	70.1	-.1	9	60.6	+9.4
Total	158	1159.2	-153.2	170	1248.7	-242.7	155	1130.8	-124.8	152	1101.3	-95.3

Grain Prices (CFA/kg)	Reg 1	Reg 2	Reg 3	Reg 4	Reg 1	Reg 2	Reg 3	Reg 4	Reg 1	Reg 2	Reg 3	Reg 4	Reg 1	Reg 2	Reg 3	Reg 4
Millet	60	40	40	40	50	30	30	30	50	40	40	40	80	40	35	35
Rice	80	85	90	90	80	85	90	90	120	100	110	110	120	100	95	95
Maize	60	40	40	40	60	40	30	30	60	40	40	40	80	30	40	40
Description:	1976 Prices				Lowering Millet Price				Raising Rice Price				Raising Rice Price Lowering Millet Price			

Where PC = per capita consumption

ND = national demand

price combination.

With price combination 2, a lowering of the millet price to encourage millet consumption, the total national grain deficit is actually increased.[28] The weak substitutability assumed between millet and the other grains accounts for the increased grain deficit. Lowering the price of millet, by the magnitudes in price combination 2, leads to an annual per capita consumption of 113 kg, an increase of 14 kg from the base level in price combination 1. Only a slight decrease in the consumption of rice (-1 kg) and maize (-1 kg) was observed. As a result the per capita annual grain consumption increased from 158 tc 170 kg. The important point to this exercise is that simply lowering the millet price will not lead to increased food self-sufficiency for Senegal. The chronic rice deficit will only be slightly affected by the decreased millet price. This is reasonable since a large portion of rice (perhaps as much as 80 percent) is consumed at mid-day when millet, because of its heaviness, is rarely consumed.[29]

Price combination 3 primarily involves an increase in the regional rice prices. The mean national rice price would be increased by 27 percent to 110 CFA/kg. As a result annual per capita rice consumption falls 24 percent from a national mean of 51 kg to 39 kg. Required rice imports fall from a projected 317,800 tons to 219,100 tons. Per capita grain consumption only falls from 158 kg to 155 kg per year, since millet consumption is stimulated from 99 kg to 106 kg. Assuming the most optimistic supply scenario, that of a 3 percent annual growth in per hectare yields, the national 1990 grain deficit is only 124,800 tons. Thus, a price policy sharply raising the consumer price of rice would succeed in greatly limiting rice imports. Further, if accompanying millet production programs succeed, the additional millet consumption can be supported from domestic production. In conclusion, such a combination of price policy and production programs could promote food grain self-sufficiency in Senegal.

It must be mentioned, however, that certain costs and equity effects would be associated with the above strategy. First, urban consumers who rely on rice for 60-65 percent of their grain requirements, would be required to pay 50 percent more for rice. A large proportion of these people can be classified as urban poor and/or unemployed. This distributional effect of the strategy cannot be ignored. Further the middle class, many of whom are civil servants, would strongly resist any significant increase in the rice price. Of course, it is possible that revenues raised through the import duty or sales tax required to increase consumer prices could offset the adverse distributional affects mentioned above.

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[28] In regions 3 and 4 the maize price was also lowered.

[29] See: Ross, Clark, "Grain Demand and Consumer Preferences, Dakar, Senegal", CRED, Discussion Paper #80, University of Michigan, June 1979.

The rural producer would also be affected by this strategy. First, he would be required to pay an additional premium for rice which he purchases. Second, with the significant increases in millet yields envisioned in the strategy, the producer may simply reallocate land and labor from millet to the more profitable groundnuts. In this case, however, millet demand, stimulated by the increased rice price, could pressure upward the millet producer price and mitigate the desire to reallocate resources from millet.

In conclusion a strategy centered around price combination 3 could serve to advance food self-sufficiency for Senegal. The costs and distributional effects of this strategy, as well as the political feasibility of the strategy, must be carefully considered.

Price combination 4 sharply raises rice prices but lowers the millet price in regions 3 and 4 in recognition of the lower than mean per capita grain consumption currently observed in those regions. Millet and maize prices were raised in region 1. The result in region 1 is a dramatic fall in annual per capita grain consumption from 165 kg to 123 kg. Without the introduction of supplementary food products - fish, vegetables, meats- such a low level of grain consumption would lead to serious problems of malnutrition in the Dakar, region 1, area. Nationally the projected rice deficit in 1990 would be 203,000 tons using supply scenario 3. The total grain deficit would only be 95,300 tons since exportable millet and maize surpluses would exist. While this strategy undoubtedly advances the goal of Senegalese grain self-sufficiency, the adverse equity and efficiency consequences associated with price policy 3, discussed above, would still exist. Further, the strategy is premised on a sharp decline in the level of grain consumption by residents of the urbanized Cap Vert area. It is unlikely that such a decline could be achieved without seriously jeopardizing the nutritional status of the Dakar population.

In summary this section has shown that price policy can advance food self-sufficiency. A policy of sharply raising rice prices could achieve meaningful reductions in rice consumption. With unchanged millet prices, overall nutritional intake would not be seriously affected. Lowering the millet price is not an effective stimulus to millet consumption if the rice price is left at its current level. Further, a decreased consumer millet price, without costly producer subsidies, would lower the producer price to the point where millet production is not attractive. Finally with the policy of raising rice prices the adverse distributional effects must be considered and some remedies introduced.

Section 3 - Major Supply Initiatives

Up to this point the discussion of grain supplies and the resulting grain balances have been premised on a continuation of current rain-fed agricultural practices. While an upgrading of rain-fed agriculture, to include greater use of animal traction, improved cultivation practices, and ameliorated seeds, is envisioned, no basic change in the structure of small scale compound-oriented agriculture has been assumed.

The government of Senegal has incorporated into its short and long term plans the development of irrigated facilities for rice and maize. Such projects would include both small scale water management schemes along rivers, tributaries, and tidal pools, as well as, the construction of large scale capital structures (generally barrages) for irrigation along the Senegal, Gambia, and Casamance rivers. The supply scenario 3 with its ambitious 3 percent annual growth in yields per hectare has implicitly incorporated some of the effects of the smaller scale projects in its growth assumption. Since some of the land surface on which the small scale developments would be implemented is now under cultivation, an increase in per hectare yields would be attributed to the introduction of small scale water management and control techniques. The larger capital projects and the development of new lands with small-scale perimeter projects have not been considered in the course of this exercise. Having examined the projected supply-demand grain balance under a variety of supply and demand scenaria, it is now appropriate to consider these planned projects and to assess their potential effects on the grain balances.

Table XXII identifies the planned water management projects for each of the three Senegalese river basins. Hectarage under cultivation and estimated production for 1990 and 2000 have been projected.

In using Table XXII certain cautions must be given. First, the planning documents from which these estimated hectarages and production have been taken generally have made projections only through 1981. In particular, for the Casamance and the Senegal Basins the 1990 projections are essentially those of 1981. This is acceptable since most of these projects have a terminal hectarage corresponding to that given for 1981 in the planning documents. Yields per hectare for 1990 and 2000, however, could be underestimated since improvement in yields from the estimated 1981 level could be expected by 1990 and 2000. Second, this listing of projects is not exhaustive; other projects for the river basins either have been discussed or pre-feasibility activity undertaken. Third, the estimated hectarages for many projects have not been verified by appropriate soil and hydrological suitability studies; thus the estimates are subject to considerable variance. Finally, when adding the projected production from these projects to the estimated production from rainfed agriculture, represented in the three previously discussed supply scenaria, no attempt has been made to net out production which might be lost as resources, particularly labor, are transferred from rainfed to irrigated cultivation. With Senegal's rapidly growing population, however, it is possible that water managed projects can be introduced with no diminution in the rainfed production projected for a given year. Nevertheless, these projections provide a reasonable indication of the possible effects from the principal water management projects.

Part A of Table XXIII shows that projected 1990 supplies of rice and of all grains with no water management projects assumed and with all water management projects of Table XXII included. All three supply scenario for rainfed agriculture are shown in this table. Part B summarizes 1990 projected grain and rice demand using (a) a continuation of current demand trends, (b) a 10 percent projected increase in per capita income, and (c) price policy 3 which sharply raises rice prices. Finally, in part C of

Table XXII - Major Water Management Projects

River Basin Project	Surface 1990(000hs)		Production 1990(000tons)		Surface 2000		Production 2000		Yields Per Hectare[c] (tons/year)	
	Maize	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize	Rice
Gambia[a]										
Kekreti[b]	4.4	13.1	22	65.5	7.2	21.8	36	109	5	5
Niokolo Koba	1.5	4.5	7.5	22.5	3.0	9.0	15	45	5	5
Total	5.9	17.6	29.5	88.0	10.2	30.8	51	154	5	5
Casamance[d]										
Nyassia-Guidel		7.6		19.0		7.6		19.0		2.5
Bignona		7.9		19.8		7.9		19.8		2.5
Soungrougrou		1.1		2.8		1.1		2.8		2.5
Baik-Kamobeul		16.0		40.0		16.0		40.0		2.5
Total		32.6		81.6		32.6		81.6		2.5
Senegal[e]										
Dagana		3.2		8.0		3.2		8.0		2.5
Bilor		2.5		6.3		2.5		6.3		2.5
Dieba		2.0		5.0		2.0		5.0		2.5
Diama		20.0		100.0		30.0		150.0		5.0
Total		27.7		119.3		37.7		169.3		4.5
Total All Basins	5.9	77.9	29.5	288.9	10.2	101.1	51	404.9	5	3.7-4.0

[a] See: Development of the Gambia River Basin, Multidisciplinary Multidonor Mission, Draft Final Report.

[b] A barrage built at Sambangalou could provide equivalent hectarage for irrigated cultivation.

[c] Yield per hectare per year is equal to Annual Cropping Rate x Yield/Crop/HA.

[d] See: V^{e} Plan Quadriennal de Developpement Economique et Social 1977-1981; Agriculture, p. 66.

[e] See: Cinquieme Plan Quadriennal de Developpement Economique et Social (Senegal) pp. 87-110

Table XXIII - 1990 Grain Balances with Water Management

A. 1990 - Supply (000 tons)

	No Water Management[a]			With Water Management[b]		
	S-1	S-2	S-3	S-11	S-21	S-31
Rice	74	98	112	243.0	267.0	281.0
All Grains	665	878	1006	850.6	1063.6	1191.6

B. 1990 - Demand - (From Chapter III) (000 tons)

	Projected Demand (D1)	Income + 10% (D2)	Price Comb.3 (D3)
Rice	391.8	427.6	293.1
All Grains	1159.2	1256.1	1130.8

C. 1990 Grain Balance With Water Management (000 tons)

	S-11 D-1	S-11 D-2	S-11 D-3	S-21 D-1	S-21 S-2	S-21 D-3	S-31 D-1	S-31 D-2	S-31 D-3
Rice	-148.8	-184.6	-50.1	-124.8	-160.6	-26.1	-110.8	-160.6	-12.1
All Grains	-308.6	-405.5	-280.2	-95.6	-192.5	-67.2	+32.4	-64.5	+60.8

[a] These three supply scenaria represent a 0, 2, and 3 per cent growth in yields per hectare, respectively, from the 1976 base year levels. See: Chapter III.

[b] For both the maize and rice production shown in Table XXII a 10 per cent post harvest loss factor has been assumed; a 65 per cent rate of transformation for paddy to clean rice has been used.

the table projected rice and grain balances are calculated for various supply and demand combinations.

Of importance is that even with the water management projects the estimated 1990 consumer rice demand cannot be satisfied. Only with the most optimistic supply assumption for rainfed agriculture (S-3) and a price policy which sharply raises the consumer rice price (D-3) can the rice deficit be held below 15,000 tons. In two cases a surplus of total grain in comparison to projected domestic demand is projected. In these cases millet and maize supplies would exceed their domestic demands by a greater amount than the excess domestic demand for rice. It should be emphasized that Table XXIII assumes that all of the previously referenced water management projects will be implemented by 1990 to the extent indicated in Table XXIII. It is of course possible that certain of these projects will not be undertaken or that some underfulfillment of the enunciated targets will occur. In this case the rice deficit as well as the accompanying total grain deficit will be larger than estimated in Table XXIII.[30]

The economic feasibility of these water management projects has not been documented in this study. In fact, for most, if not all, of these rice projects the domestic resource cost of the rice will exceed the world price for the rice currently imported. In such a case the government of Senegal must choose either to subsidize this local rice production or to raise sharply the consumer rice price and limit imports of rice.[31]

In summary this section has shown that, while not assuring self-sufficiency in rice by 1990, the planned water management projects for Senegal can contribute to increased rice supplies. Were the government to combine a price policy which raises sharply the consumer rice price with the water management projects, both grain and rice self-sufficiency could be approached. Of course, economic costs to the domestic economy and to particular groups within Senegalese society would accompany this strategy of self-sufficiency. These costs include lost groundnut production from devoting either new or existing resources to additional grain production. With Senegal's comparative advantage in groundnut production this cost could be substantial. Further, the subsidy expense potentially involved with increased millet and rice production will place a substantial burden on the government operating budget. Finally, the distributional effects of this strategy must again be considered. Both the increased consumer rice price and the additional taxes for production subsidies are apt to be regressive in incidence.[32] Chapter V has attempted to assess within the context of this grain supply-demand model the various strategies available to Senegal to insure adequate grain supplies. A continued specialization in groundnuts (Section 1), the potential for using price policy (Section 3) have all been briefly reviewed. To conclude this study Chapter VI will summarize the broad conclusions of this research.

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[30] If there is a total grain surplus, the surplus would, of course, be reduced.

[31] Since donor assistance is expected for many of these projects, the subsidy expense would undoubtedly be shared by both the relevant donor groups and the Senegalese government. There is also an infinite number of combinations of subsidy and price increases which the government could consider.

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[32] To encourage domestic millet production the government could lower the producer groundnut price, instead of subsidizing either the production or consumption of millet. This would still be regressive in its final incidence, sharply reducing rural producers' incomes.

CHAPTER VI - SUMMARY OF MAJOR RECOMMENDATIONS

This chapter will attempt to summarize the principal results of this research, focusing on their implications for food self-sufficiency in Senegal. After defining the major objectives of this research in Chapter I, a supply and demand model for millet, maize, and rice was developed in Chapter II. Per capita regional grain demands were estimated as a function of income, all grain prices, and a constant. When aggregated over region and population, these demand functions provided projections of national grain demands for a variety of underlying conditions or assumptions. The domestic supply model was less rigorous than the demand model, essentially assuming that the supply of an agricultural product was equal to hectarage multiplied by yield per hectare. Nevertheless, for given assumptions about hectares and yields domestic supply could be estimated.

In Chapter III the supply and demand model was estimated under a variety of assumptions. Demand was first calculated on the premise of unchanging per capita demands. With the assumed annual rate of population growth, steadily growing national demands for all grains were projected until the terminal year of the study, 2000. The sensitivity of this national demand to per capita income was then shown. Further, the effects of changing relative grain prices was investigated. A major conclusion was that a sharply increased consumer rice price could lead to meaningful reductions in per capita rice demand. Other testing showed that the per capita demands were relatively insensitive to changes in the overall grain price level and to changes in the assumed own price elasticities for the grains. To conclude Chapter III estimates of domestic supply for millet, rice, maize, and groundnuts were generated. Essentially, four supply scenaria were used. The first three were differentiated by the annual rate of growth in yields per hectare, assuming 0, 2, and 3 percent annual growth. There was an invariant growth rate for cultivated surface used with each of these yield growth rates. The fourth supply scenario accepted the Government of Senegal's planned 1977-1981 growth rates for yields per hectare and cultivated surface. Thus, Chapter III provides the empirical estimates of domestic grain supplies and national grain demands needed to calculate the national grain balances.

In Chapter IV grain balances using a variety of supply and demand combinations have been calculated. In the first section continued rice deficits were projected with supply scenaria 1-3.[33] By the year 2000 these deficits would be, depending upon the supply scenaria used, between 360,000 tons and 447,000 tons. With both supply scenaria 2 and 3 excess supplies of millet and maize were projected. Nevertheless, the estimated rice deficits exceeded these surpluses and Senegal would not be grain self-sufficient. An important conclusion of this exercise is the necessity to consider the composition of grain demand and supply. While grain self-sufficiency can be approached with scenario 3, serious imbalances between individual grain supplies and demands would result. At current relative grain prices, there would be surpluses in millet and maize with continued deficits in rice. Thus, unless complementary price policy schemes accompany the supply increases, problems with excess demands and supplies for individual grains will result.

A further result from the calculations in Chapter IV is that any increase in per capita income will accentuate the grain deficit. This is particularly true for rice which has the highest income elasticity, partially reflecting a desire by the rural population to introduce some diversity into its millet-based diet. Since increasing rural incomes is a priority of the Senegalese government, this conclusion must be recognized in both Senegalese and donor planning. Having shown the likely course of future grain balances in Senegal, the task of Chapter V was to investigate possible means of insuring adequate grain supplies both by domestic production and commercial imports.

Within Chapter V, three principal avenues to insure adequate grain supplies were considered. The first assumed no change in the structure of domestic grain demand or supply. A continued specialization in groundnut production primarily destined for export was assumed. The present composition of grain consumption, with rice playing a significant role, was also hypothesized. Any excess demand for rice was met with commercial rice imports. The hypothetical balance of trade accounts for the agricultural sector was continually in surplus as the value of groundnut exports greatly exceeded the value of rice imports. Nevertheless, this approach is not one readily accepted by Senegalese authorities, since it does not lead to food self-sufficiency. With both price risk and quantity variance, it can be argued that an optimal degree of domestic grain production, exceeding that implied by a static model of comparative advantage, exists.[34] In recognition of this, two strategies for promoting greater food self-sufficiency were analyzed in Chapter V.

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[33] National grain demands were estimated with unchanging regional per capita demands; increased national demand resulted solely from population growth. The implicit assumption is that relative grain prices per capita income are unchanged.

The first of these strategies relies on price policy to shift the composition of grain demand from rice towards more millet and maize. Sharply increased consumer rice prices, as detailed in Chapter V, could succeed in limiting rice demand and stimulating millet and maize consumption. Coupled with traditional extension and training programs which increase per hectare yields Senegal could approach food self-sufficiency. The exact proportion of grain demand satisfied by domestic production will depend on the magnitude of the consumer rice price increase. For those increases considered, in the range of 50 percent, a relatively substantial rice deficit--180,000 - 200,000 tons in 1990--would still exist. The second strategy considered includes the introduction of water management projects to create irrigatable land to reduce further this rice deficit.

The third section of Chapter V analyzes the impact of those water management projects being considered in current Senegalese planning documents. It is shown that food self-sufficiency can be nearly achieved by a combination of a price policy to raise the consumer rice price, productivity increases in rain-fed agriculture, and the successful introduction of the water management projects.[35]

Since both of the strategies reviewed here lead to greater food self-sufficiency, there is a temptation to endorse either of these approaches in light of Senegal's objective of food self-sufficiency. The economic costs and distributional effects of these strategies must also be considered. First, groundnut production, in which Senegal has a comparative advantage, would be reduced below the potential production implied by the resources available to Senegal. Second, the pricing policy needed to stimulate millet production would require either a producer subsidy or a consumer subsidy such that the remuneration of millet production approaches that of groundnut production. Third, the domestic resource cost of rice exceeds the current market price for imported rice. The government will either have to subsidize domestic rice production or have to raise sharply the consumer rice price. In the former case there would be a strain on the limited financial resources available to the Senegalese government. In the latter case there would be adverse distributional effects for low and middle income urban inhabitants who depend on rice for 60 percent of their grain requirements. Thus, it is the obligation of Senegalese policymakers to weigh the relative benefits and costs to any strategy promoting greater food self-sufficiency.

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[34] Jabara, Cathy, "Agricultural Comparative Advantage Under Uncertainty, The Case of Senegal" Unpublished PH.D. Thesis, Purdue University, May 1979.

[35] By 1990 a potential surplus of 60,800 tons of grain could exist. This includes a millet and maize surplus of 72,900 tons and a small rice deficit of 12,100 tons.

This modeling of Senegalese grain demands and supplies has tried to provide a methodology capable of incorporating the various elements needed to analyze food policy. The demand model provides projections of domestic grain demands for a variety of underlying assumptions. Coupled with estimates of grain supplies, projected grain balances can be derived and various strategies assessed. Policymakers must now refine the model as more accurate data become available, enunciate their objectives with respect to food production, and design a strategy or policy to achieve those objectives.

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by

John Staatz

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CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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* * * *

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THE ECONOMICS OF CATTLE AND MEAT MARKETING IN IVORY COAST -
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ABSTRACT

This paper evaluates the economic performance of the cattle and meat marketing system in Ivory Coast, based on 18 months of field research. The paper discusses recent changes in Ivory Coast's pattern of meat supply, the current organization of the cattle and meat trades, the need for improved market infrastructure, and the problems and costs of transporting cattle and meat to and within Ivory Coast. It also discusses determinants of the most profitable location for slaughter, and what the current patterns of cattle and meat prices imply for the financial viability of proposed cattle fattening projects. The paper concludes with a set of policy recommendations. The marketing system was found to be rather efficient given the infrastructure and institutional framework within which it operates. Major improvements in market performance, however, could result from upgrading livestock transportation and market infrastructure and from changing some of the rules under which the cattle and meat trades operate.

SOMMAIRE

Ce document évalue les résultats économiques du systéme de commercialisation du bétail et de la viande en Côte d'Ivoire, ceux-ci étant basés sur 18 mois de recherches sur le terrain. Il examine également certains changements récents, tels que ceux ayant affecté le schéma de l'approvisionnement en viande, l'organisation actuelle du commerce du bétail et de la viande, le besoin d'une meilleure infrastructure commerciale, et les problémes et les coûts du transport des bovins et de la viande à l'intéreur et à l'extérieur de la Côte d'Ivoire. Ce rapport aborde ensuite la question cruciale de l'emplacement idéal des centres d'abattage ainsi que les implications du modéle actuel des prix du bétail et de la viande sur la viabilité financiére des projets d'embouche envisagés. Enfin, en guise de conclusion, cet ouvrage offre un ensemble de recommandations d'action. L'efficacité du système en place s'avére incontestable étant donné le cartre institutionnel et infrastructure à l'intérieur du quel il opére. Toutefois, toute amélioration du transport des animaux, de l'infrastructure de marché et des réglements le régissant pourrait entraîner des progrés notables du rendement commercial.

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INTRODUCTION

This study examines the organization and recent evolution of the markets for cattle and meat in Ivory Coast, and discusses constraints to expansion of the Ivorian cattle and meat trades. Ivory Coast plays a crucial role in cattle and meat marketing in central West Africa. Relative economic prosperity has resulted in a strong demand for meat, making Ivory Coast an important market for livestock exprots from the Sahelian countries, particularly from Mali and Upper Volta. Livestock production traditionally has played a small role in the Ivorian economy, and the country is highly dependent on imports for the bulk of its red meat supply, including over 80 percent of its beef.

With the recent decline in the Ghanian market for meat, Mali and Upper Volta have become increasingly dependent on Ivory Coast as a market for their livestock exports. In 1970 Ivory Coast bought 60 percent of Mali's cattle exports and 67 percent of Upper Volta's cattle exports; by 1975, it absorbed 83 percent of Mali's cattle exports and 87 percent of Upper Volta's cattle exports (24, pp. 96-7, 150-60; 6, p. 115; 20).[1] Changes in the Ivorian market therefore affect not only the welfare of livestock producers and meat consumers within Ivory Coast, but also the incomes of livestock producers and traders in Mali and Upper Volta, as well as the export earnings and tax revenues of these livestock-exporting countries.

In recent years, the Ivorian market for cattle and meat has changed markedly as a result of the drought in the Sahel and changes in the world beef market. The drought had two long-term effects on the livestock trade in West Africa. First, it reduced the number of animals available in the Sahelian countries for export to the coastal states. The results were higher livestock and meat prices in both the Sahelian and the coastal countries.[2] Second, donor agencies and the West African governments responded to the losses of livestock suffered during the drought by creating new organizations to coordinate livestock policy and designing new programs aimed at changing the way in which livestock and meat traditionally had been produced and marketed. On the production side, planners tried to encourage regional stratification of livestock, particularly cattle production. Arid Sahelian zones were to be used as breeding areas, with growing out occurring in more humid zones, and final fattening taking place near terminal markets or export zone abattoirs (22, p.i). On the marketing side, livestock markets were rebuilt and equipped with cattle scales and other materiel; modern abattoirs were constructed in the Sahelian states, with the goal of exporting chilled meat to the coastal states; governments encouraged merchants to truck rather than trek their livestock to market, in order to reduce weight losses during shipment and crop damage by trade herds; and inter-African organizations called for widespread reorganization of the professions engaged in livestock and meat marketing. (See, for example, 5.)

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[1] The numbers in parentheses indicate the references cited. The list of citations is at the end of the study.

[2] The initial effect of the drought, especially in the Sahel, was to depress livestock prices, as livestock raisers were forced to destock their herds in order to meet their cash needs. This was a short-term effect, however, followed by an increase in prices as the supply of livestock fell.

In addition to the drought, changes in the world beef market during the mid 1970s had a strong impact on cattle and meat marketing in West Africa, particularly in the coastal states. Traditional meat exporting countries, such as Argentina, faced with increased stocks of meat in 1975, began prospecting for new markets, including West Africa. In 1975 Ivory Coast was faced with a shortage of livestock and meat from its traditional suppliers, the Sahelian countries, and therefore began importing large amounts of frozen beef from overseas. As a result, the share of the Ivorian beef supply made up by imports from non-West African countries grew from 0.3 percent in 1974 to 37.6 percent in 1976.

This study was conducted in order to analyze these recent changes in the Ivorian market for cattle and meat and to identify constraints to expansion of the cattle and meat trades. The study involved analysis of data already collected by agencies of the Ivorian government, as well as collection and analysis of additional data in Abidjan and Bouaké. The research in Ivory Coast upon which this study is based took place between March 1976 and July 1977. The major findings of the study are presented below in seven sections. The first section examines the recent evolution of Ivory Coast's red meat supply, showing the changes that occurred from

1970 through 1976 in domestic livestock production and in imports of livestock and meat. The second section looks at the current organization and functioning of cattle and meat markets in Ivory Coast and discusses whether the current market organization represents a constraint to expansion of the trade. The third section examines the need for improved physical infrastructure for cattle and meat marketing in Ivory Coast. The fourth section describes the problems and costs of transporting cattle in Ivory Coast and discusses the implications of these costs for transportation policy. The fifth section examines the conditions under which it would become more profitable to slaughter cattle in the north (near where they are produced) and ship their carcasses south than to ship the cattle south for slaughter, as is currently done. The sixth section examines variations in cattle and meat prices in Abidjan and Bouaké during 1976-77 and uses these price variations to draw inferences about the nature of the demand for cattle and meat in Ivory Coast; the section then discusses the implications of this pattern of demand for cattle fattening projects in the north. Finally, the seventh section summarizes the major conclusions of the study and makes policy recommendations aimed at improving cattle and meat marketing in Ivory Coast.

THE RECENT EVOLUTION OF IVORY COAST'S RED MEAT SUPPLY[1]

The meat Ivory Coast consumes comes from three sources: domestic production, imports of live animals from the Sahelian countries, and imports of chilled and frozen meat. Through 1974, imports of live animals, especially cattle, were by far the most important source of supply. SEDES figures (24, pp. 439-41, 450-52) indicate that in 1970 imports of live animals provided 73 percent of Ivory Coast's total red meat supply and 84 percent of its beef supply. Domestic production accounted for 23 percent of the red meat supply and 12 percent of the beef supply, while imports of chilled and frozen meat made up the remaining 4 percent of the red meat supply and 4 percent of the beef supply. Beef was the most widely consumed red meat in the country, accounting for 75 percent of total consumption. Goat meat and mutton made up 20 percent, and pork accounted for the remaining 5 percent.

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[1] The recent evolution of the Ivorian market for red meat and its outlook through 1985 is discussed in detail in a forthcoming report by the author. This report, to be published in 1979, is part of a larger study on livestock and meat marketing in the "central corridor" of West Africa, being conducted by the University of Michigan's Center for Research on Economic Development for the United States Agency for International Development (Contract REDSO/WA 77-105).

Figures presented below indicate that the pattern of consumption in 1976 was about the same as in 1970. The pattern of supply, however, had changed radically. In 1976, imports of livestock from the Sahelian countries accounted for only 45 percent of the Ivorian red meat supply. Domestic production made up 26 percent of the total supply, and imports of chilled and frozen meat accounted for 29 percent. Obviously, the Ivorian market for meat changed considerably between 1970 and 1976, as the figures presented below domonstrate.

Domestic Livestock Production

Table 1 shows the small role that livestock production, and particularly cattle production, play in the Ivorian economy. In 1974, total livestock production accounted for only 2.5 percent of Ivory Coast's GDP, with 1.0 percent of this being attributable to red meat production and merely 0.4 percent to cattle production. In contrast, agriculture contributed 28.9 percent of the GDP in 1974 (11, p. 84). For health and economic reasons, there is little tradition of cattle raising in Ivory Coast, and the country has met its meat requirements (especially its beef requirement) by importing live animals from the Sahelian countries,as stated in the introduction.[1]

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[1] Because of the many livestock diseases endemic in the country (e.g., trypanosomiasis, contagious bovine pleuro-pneumonia) and the humid climate of the southern half of the country, Ivory Coast has had a comparative advantage in export crop production over livestock production. The country has found it cheaper to produce and sell export crops and use the receipts to import its meat from its northern neighbors (largely in the form of live animals) than to produce the meat itself.

TABLE 1

ESTIMATED VALUE OF LIVESTOCK PRODUCTION IN IVORY COAST IN 1974
(in millions of CFA F)

	Cattle	Sheep/Goats	Swine	Poultry	Eggs,Milk Hides,etc.	Total
Value	1,560	1,447	1,207	5,260	753	10,227
Percent of GDP	0.4	0.3	0.3	1.3	0.2	2.5

SOURCE: République de Côte d'Ivoire, Ministère du Plan, *La Côte d'Ivoire en chiffres*, 84, 149.

Domestic Beef Production.-- Two species of cattle are raised in Ivory Coast -- zebus, or humped cattle (varieties of the species *Bos indicus*), and taurins, or humpless cattle (varieties of the species *Bos taurus*). Zebus, which numbered about 115,000 head in 1976, are highly susceptible to trypanosomiasis and other diseases endemic in the humid regions of Ivory Coast. They are therefore raised exclusively in the dryer savanna areas of the north. Taurins raised in Ivory Coast have some resistance to trypanosomiasis and are found throughout the country, although they, too, are concentrated in the north. Three distinct breeds of taurins are raised in Ivory Coast. *Baoulés*, a type of West African shorthorn, are by far the most numerous, accounting for about 300,000 head. *N'dama's*, a slightly larger breed, number between 40,000 and 60,000 head, and are concentrated in the northwest of the country, around Odienné. *Lagune* cattle account for only about 4,500 head. They are extremely small, highly disease resistant cattle found along the coast.

Table 2 presents estimates of Ivory Coast's domestic beef production from 1970 through 1976.[1] Table 2 shows that domestic beef production grew from 4,700 tons in 1970 to 6,923 tons in 1976, an increase of 46 percent, or approximately 6.5 percent per year. One reason for this rapid growth was that many Fulani herders moved their animals into Ivory Coast during

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[1] For discussion of the data upon which Table 2 is based, see 27, Chapter 1.

TABLE 2

ESTIMATE OF IVORIAN DOMESTIC BEEF PRODUCTION: 1970-76 (tons)

Year	Cattle Population[a]	Off-take Rate	Number Slaughtered	Ave. Carcass Weight	Meat Production (tons)	Edible Offals[b] (tons)	Total (tons)
Taurins							
1970	289,000	10%	28,900	100 kg.	2,890.0	722.5	3,612.5
1971	297,600	"	29,760	"	2,976.0	744.0	3,720.0
1972	306,600	"	30,660	"	3,066.0	766.5	3,832.5
1973	315,800	"	31,580	"	3,158.0	789.5	3,947.5
1974	325,200	"	32,520	"	3,252.0	813.0	4,065.0
1975	335,000	"	33,500	"	3,350.0	837.5	4,187.5
1976	345,000	"	34,500	"	3,450.0	862.5	4,312.5
Zebus							
1970	50,000	12%	6,000	145 kg.	870.0	217.5	1,087.5
1971	70,000	"	8,400	"	1,218.0	304.5	1,522.5
1972	77,000	"	9,240	"	1,339.8	335.0	1,674.8
1973	85,000	"	10,200	"	1,479.0	369.8	1,848.8
1974	105,000	"	12,600	"	1,827.0	456.8	2,283.8
1975	115,000	"	13,800	"	2,001.0	500.3	2,501.3
1976	120,000	"	14,400	"	2,088.0	522.0	2,610.0
Total Production							
1970	339,000		34,900		3,760.0	940.0	4,700.0
1971	367,600		38,160		4,194.0	1,048.5	5,242.5
1972	383,600		39,900		4,405.8	1,101.5	5,507.3
1973	400,800		41,780		4,637.0	1,159.3	5,796.3
1974	430,200		45,120		5,079.0	1,269.8	6,348.8
1975	450,000		47,300		5,351.0	1,337.8	6,688.8
1976	465,000		48,900		5,538.0	1,384.5	6,922.5

NOTES: Based on data from République de Côte-d'Ivoire, Ministère de la Production Animale, and the following assumptions:

a Cattle population:
  1) Taurins: Based on a population of 335,000 in 1975 and a 3 percent annual growth rate
  2) Zebus: Figures provided by Ministry of Animal Production

b Edible offals estimated at 25 percent of carcass weight.

Estimates of carcass weights and off-take rates provided by the Ministère de la Production Animale.

the early 1970s to avoid the drought farther north in Mali and Upper Volta. Between 1970 and 1976, the number of zebus in Ivory Coast increased by 140 percent.

Domestic Production of Small Ruminants.-- No solid statistics exist on the number of small ruminants in Ivory Coast. Estimates run from 1.3 million (16), to 1.8 million (15, p. 14). The Planning Ministry estimated there were 1,000,000 sheep and 760,000 goats in the country in 1975, with sheep producing 3,500 tons of meat and edible offals and goats producing 2,000 tons (12). Lacking more accurate statistics, the figures of the Planning Ministry are used in this report.

Domestic Pork Production.-- Pork production in Ivory Coast takes place both in villages and in a few modern pig farms. The official estimate of pork production in 1975 was 5,000 tons, of which 3,600 tons came from traditional village production, and 1,400 tons came from modern pig farms. In contrast to other types of red meat, Ivory Coast is largely self-sufficient in pork, producing 98 percent of its domestic consumption (12, Tables 6, 10).

Game.-- In addition to the red meat production just mentioned, officials estimated the production of game, snails, and other viande de brousse equaled 16,000 tons in 1975 (12, Table 10). One must regard this figure with caution, however, as there are practically no data on which to base such an estimate.

Domestic Production: A Summary.-- Table 3 summarizes Ivory Coast's domestic red meat production in 1975. In 1975 Ivory Coast produced about 17,000 tons of red meat, excluding game, out of a total domestic consumption (excluding game) of roughly 53,000 tons.

TABLE 3

ESTIMATED IVORIAN RED MEAT PRODUCTION IN 1975
(tons of meat and edible offals)

Beef	6,689
Mutton	3,500
Goat Meat	2,000
Pork	5,000
Subtotal	17,189
Game[a]	16,000

SOURCES: Table 1, and text.

[a] The reliability of the figure for game is questionable.

Livestock Imports

Given the low level of domestic livestock production, Ivory Coast has traditionally relied on imports of cattle and small ruminants from the Sahelian countries to provide the bulk of its red meat supply. This section outlines recent changes in the pattern of livestock imports.

Cattle Imports.-- Table 4 presents officially recorded imports of cattle into Ivory Coast from 1965 through 1976. Between 1965 and 1970, officially recorded cattle imports increased steadily, rising from 80,200 to 198,000 head. The annual average rate of increase of recorded cattle imports during this period was 20 percent. Real per capita income was increasing rapidly during this period and undoubtedly was one of the main forces boosting demand for meat, hence cattle. Larger exports from Mali accounted for much of the increase over this period. Mali's share of the market increased from 30.5 percent in 1965 to 65.8 percent in 1969. During the same period. the number of cattle imported from Upper Volta actually fell by about 12,000, and the Voltaic share of the market fell

TABLE 4

OFFICIALLY RECORDED IMPORTS OF CATTLE INTO IVORY COAST: 1965-76

	Mali		Mauritania		Upper Volta		Niger		France		Total	
Year	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent[a]
1965	24,446	30.5	1,914	2.4	53,828	67.1	10	—	—	—	80.198	100.0
1966	19,996	19.7	37,234	36.6	44,273	43.6	119	0.1	—	—	101,622	100.0
1967	46,063	38.5	16,739	14.0	56,123	46.9	718	0.6	—	—	119,643	100.0
1968	67,836	41.2	16,356	9.9	80,566	48.9	—	—	—	—	164,758	100.0
1969	113,234	65.8	16,908	9.8	41,335	24.0	567	0.3	—	—	172,064	100.0
1970	143,080[b]	72.1[b]	b	b	51,199	25.8	4,121	2.1	—	—	198.400	100.0
1971	--	--	--	--	--	--	--	--	—	—	175,896	100.0
1972	137,074[b]	64.5[b]	b	b	73,658	34.7	1,746	0.8	—	—	212,478	100.0
1973	117,942	52.7	29,001	13.0	73,054	32.6	3,938	1.7	—	—	223,935	100.0
1974	123,148	63.6	31,397	16.2	39,084	20.2	—	—	—	—	193,629	100.0
1975	77,065	54.7	5,069	3.6	58,441	41.5	395	0.3	—	—	140,970	100.0
1976	75,851	67.5	830	0.7	35,264	31.4	—	—	369	0.3	112,314	100.0

SOURCE: République de Côte-d'Ivoire, Ministère de la Production Animale, unpublished data; République de Côte-d'Ivoire, Ministère de l'Economie et des Finances, Direction de la Statistique, Situation économique de la Côte-d'Ivoire, various issues; and SEDES, Receuil statistique de la production animale, study done for République Française, Ministère de la Coopération (Paris: 1975), p. 450.

NOTES:

--- Not available

— None or negligible

The Ivorian Ministry of Animal Production accepts the figures published in the Receuil statistique de la production animale as the official figures for years prior to 1972. These figures differ in some years from the figures reported by the Veterinary Service and published in Situation économique de la Côte-d'Ivoire. For 1966 and 1967, these differences are very small; therefore the Veterinary Service's statistics are used, since they give the country of origin of the imported animals, which the SEDES figures for 1966 and 1967 do not. In years where there are large differences between the Veterinary Service's statistics and the SEDES figures, the latter are used. Figures for the years 1973-76 are from unpublished data of the Ministry of Animal Production.

[a] Totals may differ slightly from sum of subtotals due to rounding.

[b] Figures for Mauritania included in the figures for Mali.

from 67 percent to 24 percent.[1] Much of the recorded increase in Malian exports was probably due to the lifting of Malian exchange controls in 1967 and the reduction in the Malian export tax on cattle in 1969 (28, p. 9). The growth of Malian exports was also tied to the growth of Ivorian cities such as Daloa, Yamoussoukro, San Pedro, and Bouaké, whose meat supply is met by Malian animals transported south on hoof.

In 1971, total recorded imports fell by almost 23,000 head, reflecting the impact of the drought in the Sahel. Faced with increased mortality, Sahelian herders apparently held back animals and tried to maintain their herds. This was followed in 1972 through 1974 by a destocking of herds as the drought became more severe, and herders were obliged to sell even young males and cows to meet their cash needs. This destocking of northern herds is reflected in increased cattle imports into Ivory Coast during 1972-1973, particularly by a sharp increase in imports from Mauritania, where the effects of the drought were severe. The high level of cattle imports into Ivory Coast from Mali during the period 1970-74 was also a by-product of the decline in the Ghanaian market for beef, which resulted from economic instability and the reorganization of the cattle trade in Ghana. Many of the cattle that "normally" would have been exported to Ghana ended up in Ivory Coast during this period.

In 1974, total recorded cattle imports into Ivory Coast fell by 30,000 head from the previous year. The decline in recorded imports continued at an accelerating rate in 1975. Imports fell in 1975 not only because the marketable surplus of animals in the Sahelian countries was reduced by the drought and the subsequent destocking of herds in 1972-74, but also because Mali and Niger closed their borders to livestock exports during part of the year. This did not cut off the trade completely, but it certainly reduced it. Imports were also reduced because of the hostilities between Upper Volta and Mali, which essentially ended the transit of Malian animals through Upper Volta along the route

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[1] Part of the apparent growth in the Malian share of the market probably reflected an improvement in the statistics gathered along the Mali-Ivory Coast border.

Mopti-San-Bobo-Dioulasso-Ouangolodougou (Ivory Coast). In response to this drop in total cattle imports, the Ivorian government, through its state-owned company AGRIPAC, began importing large amounts of frozen meat, mainly from Europe, in September 1975.

The decline in recorded imports continued in 1976, falling to 112,314 head. Imports continued to fall in 1976 for two reasons. First, the effects of the drought continued to be felt. (Many of the young animals that died in 1969-72 normally would have been marketed in 1976.) Secondly, part of Ivory Coast's "normal" supply of cattle, particularly from Upper Volta, apparently was diverted toward more profitable markets in Niger and Nigeria. The high prices offered in Niger stemmed from two causes: the Nigerien herd reconstitution program, which resulted in high prices being offered for young animals, especially heifers; and the strong demand for slaughter animals in Nigeria.[1] Many Voltaic cattle merchants abandoned the Abidjan market in 1976 to sell their animals at Téra, on the border between Niger and Upper Volta. It thus appears that the Ivorian government's policy of importing large amounts of cheap frozen meat in order to hold down meat prices in the major retail markets had the effect of diverting part of the traditional supply of slaughter animals, particularly from Upper Volta, to more profitable markets elsewhere.[2]

Imports of Sheep and Goats.-- Table 5 presents officially recorded imports of sheep and goats from 1965 through 1976. In general, the pattern of small ruminant imports was the same as that for cattle. Recorded imports more than doubled between 1965 and 1970, declined slightly

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[1] Because the port of Lagos was blocked throughout 1976, Nigeria was not able to adopt the Ivorian expedient of importing large quantities of frozen meat by sea in order to hold down retail meat prices. As a result, prices for cattle in Lagos reportedly rose to approximately 300 CFA F per kg. liveweight near the end of 1976, compared to roughly 210 CFA F per kg. liveweight in Abidjan (10).

[2] Many Voltaic cattle merchants complained to the investigator that the Abidjan market had been "ruined" by frozen meat imports.

TABLE 5

OFFICIALLY RECORDED IMPORTS OF SHEEP AND GOATS INTO IVORY COAST: 1965-76

Year	Mali		Mauritania		Upper Volta		Niger		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent[a]
1965	39,902	28.1	4,936	3.5	86,347	60.8	10,780	7.6	141,965	100.0
1966	18,875	10.4	107,072	59.1	55,311	30.5	—	—	181,258	100.0
1967	--	--	--	--	--	--	--	--	180,517	100.0
1968	27,605	12.3	15,568	6.9	182,015	80.8	—	—	225,188	100.0
1969	89,503	32.0	29,928	10.7	159,929[b]	57.4[b]	b	b	279,360	100.0
1970	122,673	39.6	36,135	11.7	128,490	41.5	22,104	7.1	309,402	100.0
1971	--	--	--	--	--	--	--	--	303,479	100.0
1972	--	--	--	--	--	--	--	--	394,044[c]	100.0
1973	147,295	34.5	23,991	5.6	241,137	56.5	14,636	3.4	427,059	100.0
1974	165,710	42.9	29,919	7.8	187,804	48.7	2,397	0.6	385,830	100.0
1975	96,005	27.2	2,811	0.8	253,517	71.9	309	0.1	352,642	100.0
1976	130,744	43.5	—	—	167,264	55.7	2,263	0.8	300,305	100.0

SOURCES: République de Côte-d'Ivoire, Ministère de la Production Animale, unpublished data; République de Côte-d'Ivoire, Ministère de l'Economie et des Finances, Direction de la Statistique, Situation économique de la Côte-d'Ivoire, various issues; and SEDES, Receuil statistique de la production animale, study done for République Française, Ministère de la Coopération (Paris: 1975), p. 45.

NOTES:

-- Not available

— None or negligible

The Ivorian Ministry of Animal Production accepts the figures published in the Receuil statistique de la production animale as the official figures for the years prior to 1972. These figures differ in some years from the figures reported by the Veterinary Service and published in Situation économique de la Côte-d'Ivoire. In years where there are large differences between the Veterinary Service's statistics and the SEDES figures, the latter are used. Figures for the years 1973-76 are from unpublished data of the Ministry of Animal Production.

[a] Totals may differ slightly from sum of subrotals due to rounding.

[b] Figures for Niger included in the figures for Upper Volta.

[c] Recently revised figure, differs from figure previously published by Ministry of Animal Production.

from 1970 to 1971, increased sharply in 1972 and 1973, and then declined markedly from 1973 through 1976.[1] It appears that the same forces that affected cattle imports influenced sheep and goat imports. Rapidly rising incomes in the period 1965-1970 stimulated demand for meat, and imports grew. The effects of the drought started to be felt in 1971, resulting in a slight reduction of imports in that year, followed by a massive destocking of herds in 1972 and 1973. This destocking boosted imports into Ivory Coast during these two years, but was followed by a decline in recorded imports from 1973 through 1976, as the number of animals available for sale from the Sahelian countries dropped as a result of the destocking. Recorded imports of sheep and goats fell proportionately less than did recorded cattle imports, however, declining by roughly 30 percent from 1973 to 1976, compared with a 50 percent drop in recorded cattle imports during the same period. In 1976, recorded sheep and goat imports stood at the same level as in 1970, whereas recorded cattle imports were considerably below their 1970 levels. Sheep and goat imports suffered less direct competition from frozen meat imports than did cattle imports, as the bulk of the frozen meat imported was beef, and practically no frozen mutton or goat meat was sold on the traditional African market.[2]

Tonnage of Meat Imported on the Hoof.-- The destocking of cattle herds in the Sahelian countries during the period 1972-76 resulted in a change in the composition by sex of cattle herds imported for slaughter in Ivory Coast. As the drought reduced herd sizes in the north, cattle owners were forced to sell even females and young males to meet their cash needs. As a result, the average carcass weight of cattle slaughtered in Abidjan fell from 151 kg in 1970 to 138 kg in 1976.[1] The carcass weights of small ruminants may also have fallen during this period, but data are unavailable to confirm this. Therefore, in the following calculations, a constant carcass weight of 17 kg is assumed for small ruminants. (This weight is taken from 23, p. 117.)

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[1] The official Ivorian statistics on imports of small ruminants, at least from Upper Volta, appear less accurate than those for cattle, however. For four of the five years for which comparable data are available (1970 and 1973-76), Ivorian import statistics show an average of 20 percent fewer Voltaic small ruminants arriving in Ivory Coast than the Voltaic figures indicate left that country for Ivory Coast. The Voltaic figures, however, show the same pattern of fluctuations as the Ivorian statistics.

[2] Sales of sheep and goats may have been affected indirectly if consumers shifted from mutton to beef consumption as relatively inexpensive frozen beef became available. This probably did not happen very much. Many of the sheep sold in Ivory Coast are slaughtered for ceremonial occasions. In these circumstances, consumers do not consider beef an acceptable substitute for mutton.

Table 6 presents the estimated tonnage of beef and small ruminant meat imported into Ivory Coast from 1970 through 1976, based on the data presented in Tables 4 and 5 and the average carcass weights mentioned above. Table 6 shows that the total tonnage of beef imported on the hoof fell by nearly half between 1970 and 1976, from 37,448 tons to 20,076 tons. A small part of this decline was offset by an increase in domestic production resulting from Fulani cattlemen moving their herds south into Ivory Coast to escape the drought, but most of it was not met by a corresponding increase in other fresh beef supplies. The result was a decreasing total and per capita fresh beef supply throughout this period. Table 6 also shows that the tonnage of meat represented by recorded small ruminant imports rose from roughly 6,000 tons in 1970 to 8,300 tons in 1973, then fell to less than 6,000 tons in 1976. The Ivorian Planning Ministry (12, Table 10) estimates that imports were somewhat higher than indicated in Table 6, roughly 6,800 tons in 1970 and 8,000 tons in 1975. Examination of Voltaic export statistics (see p. 156, footnote 1) supports the view that the official Ivorian statistics underestimate the number of small ruminants imported. The tonnage of mutton and goat meat imported on the hoof in 1976 was probably closer to 7,000 tons than the 5,900 tons indicated in Table 6.

Imports of Chilled and Frozen Meat

In addition to domestic production and imports of live animals, imports of chilled and frozen meat are the other main source of meat supply

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[1] See 27, pp. 35-38 for details of how these average carcass weights were estimated.

TABLE 6

ESTIMATED TONNAGE OF BEEF, MUTTON, AND GOAT MEAT IMPORTED INTO IVORY COAST ON THE HOOF: 1970-76

Year	Number of Animals Imported	Average Carcass Weight (kg.)	Meat (Tons)	Edible Offals (tons)[a]	Total (tons)
BEEF					
1970	198,400	151	29,958	7,490	37,448
1971	175,896	149	26,209	6,522	32,761
1972	212,478	142	30,172	7,543	37,715
1973	223,935	139	31,127	7,782	38,909
1974	193,629	140	27,108	6,777	33,885
1975	140,970	138	19,454	4,863	24,317
1976	112,314	143	16,061	4,015	20,076
MUTTON AND GOAT MEAT					
1970	309,402	17	5,260	789	6,049
1971	303,479	17	5,164	744	5,908
1972	394,044	17	6,699	1,005	7,704
1973	27,059	17	7,260	1,089	8,349
1974	385,830	17	6,559	984	7,543
1975	352,642	17	5,995	899	6,894
1976	300,305	17	5,105	766	5,871

SOURCES; Tables 4 and 5. Average slaughter weights for cattle from Staatz, John M., The Economics of Cattle and Meat Marketing in Ivory Coast (Ann Arbor: Center for Research on Economic Development, 1979), pp. 35-8. Average slaughter weights for small ruminants from SEDES, Approvisionnement en viandes de l'Afrique centre ouest, Secretariat d'Etat aux Affaires Etrangères (France) and Conseil de l'Entente (Paris: 1969), p. 117.

[a] Estimated at 25 percent of carcass weight for cattle and 15 percent of carcass weight for small ruminants.

for Ivory Coast. Until 1975, these imports represented a modest volume and were destined almost exclusively for a high-income, largely expatriate clientele in Abidjan. In 1975, however, the pattern completely changed, with large amounts of imported frozen meat (mainly beef) being sold on the traditional African market. Table 7 shows how the volume and sources of supply of Ivory Coast's imports of chilled and frozen meat changed from 1960 through 1976.[1]

From 1960 to 1970 recorded imports of chilled and frozen red meat increased from about 500 tons to 2,000 tons per year. Between 60 and 75 percent of this meat was beef, depending on the year, and the bulk of it came from Upper Volta. Recorded imports of chilled and frozen meat declined from 1970 through 1974, reflecting the ending of chilled meat shipments from Mali, Ivory Coast's increasing self-sufficiency in pork production, and a decline in the quality of refrigerated rail transport between Upper Volta and Abidjan.

The decline in chilled frozen meat imports continued through the first half of 1975. The abrupt drop in live animal imports in 1975 reduced the total meat supply on the market, and, in order to check the resulting price rise, the Ivorian government began importing surplus frozen meat from Europe. In one year, recorded imports jumped from 1,473 tons to 6,329 tons. In 1976, recorded imports increased even more rapidly, reaching 17,030 tons, much of it from South America. Almost all this new frozen meat was beef; as a result, beef accounted for over 97 percent of the imports in 1976, compared with 81 percent in the 1971-74 period.

In contrast to previous years, the bulk of the chilled and frozen meat imported in 1975 and 1976 was destined for the traditional African market, not a high-income clientele. This meat was sold on the traditional market (with bones) for between 50 to 100 CFA F less per kg than locally slaughtered meat, which sold in 1976 in Abidjan for 350 to 400 CFA F per kg.

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[1] For a breakdown of imports by type of meat, see 27, p. 36.

TABLE 7

RECORDED IMPORTS OF CHILLED AND FROZEN RED MEAT BY COUNTRY OF ORIGIN: 1960-76 (tons)

Year	Mali		Upper Volta		Niger		Other African Countries		Total African Countries		Europe		South America		Total[a]	
	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent
1960	77	14.6	260	49.2	42	8.0	—	—	379	71.8	149	28.2	—	—	528	100.0
1961	—	—	471	54.0	179	20.5	—	—	650	74.5	223	25.5	—	—	873	100.0
1962	—	—	782	70.1	186	16.7	—	—	968	86.8	147	13.2	—	—	1,115	100.0
1963	95	6.4	910	60.9	270	18.1	—	—	1,275	85.3	219	14.7	—	—	1,494	100.0
1964	181	11.3	979	61.0	220	13.7	—	—	1,380	86.0	225	14.0	—	—	1,605	100.0
1965	167	10.7	960	61.3	236	15.1	—	—	1,363	87.0	203	13.0	—	—	1,567	100.0
1966	309	16.2	935	48.9	473	24.8	—	—	1,717	90.9	194	10.1	—	—	1,911	100.0
1967	57	3.0	1,317	68.5	363	18.9	—	—	1,737	90.3	188	9.7	—	—	1,924	100.0
1968	95	4.8	1,304	65.9	418	21.1	—	—	1,817	91.9	160	8.1	—	—	1,978	100.0
1969	179	9.0	1,232	61.7	406	20.3	—	—	1,817	90.9	181	9.1	—	—	1,998	100.0
1970	153	7.6	1,176	58.8	487	24.3	—	—	1,816	90.7	186	9.3	—	—	2,001	100.0
1971	—	—	1,326	72.1	340	18.5	—	—	1,666	90.6	173	9.4	—	—	1,839	100.0
1972	—	—	1,065	71.3	234	15.7	—	—	1,299	87.0	194	13.0	—	—	1,494	100.0
1973	—	—	915	70.7	194	15.0	—	—	1,109	85.7	185	14.3	—	—	1,294	100.0
1974	—	—	1,078	73.2	187	12.7	8	0.5	1,273	86.4	199	13.5	—	—	1,473	100.0
1975	—	—	591	9.3	277	4.4	891	14.1	1,759	27.8	3,990	63.0	580	9.2	6,329	100.0
1976	—	—	247	1.5	162	1.0	896	5.3	1,305	7.7	2,669	15.7	13,056	76.7	17,030	100.0

SOURCE: République de Côte-d'Ivoire, Ministère de la Production Animale, unpublished data.

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[a] Totals may differ slightly from sum of subtotals due to rounding.

The large imports of frozen meat were initially a reaction to and not the cause of the decline in live animal imports in 1975. Imports of live animals fell sharply in mid-1975 and it was not until September that the massive frozen meat imports began. Once started, however, the sales of cheap frozen meat had the effect of checking the price increase of fresh meat and, as mentioned above, may have served to reduce live animal imports, particularly from Upper Volta.

Not only did the quantities of frozen and chilled meat imported increase tremendously between 1974 and 1976; the pattern of supply completely changed, as well. Up until 1975, the Sahelian countries usually accounted for between 85 and 90 percent of Ivory Coast's recorded frozen and chilled meat imports, with Europe (mainly France) making up the rest. In 1975, however, large imports arrived from Europe, non-Sahelian Africa, and, for the first time, South America. In one year, the combined market share of Mali, Upper Volta, and Niger fell from 85.9 percent to 13.7 percent, and by 1976 it represented only 2.5 percent of total recorded meat imports.

Non-African suppliers entered the Ivorian meat market in 1975 for two reasons. Meat prices in Ivory Coast rose sharply in 1975 because of the shortage of local slaughter animals, thus making Ivory Coast a more attractive market to overseas meat suppliers. More importantly, the world's traditional meat-exporting countries, especially Argentina, were faced with increased stocks of meat in 1975 and fewer markets in which to sell. These countries had expanded their beef production in the early 1970s in response to rising consumer incomes in most developed countries. With the economic slowdown and rise in grain prices in 1973, however, most meat importing countries imposed import restrictions on beef in order to protect domestic producers. This left the meat-exporting countries with large stocks of unsold meat, forcing them to seek out new markets, including West Africa. Ivory Coast was thus able to find very inexpensive frozen beef on the world market just at the time when its traditional beef suppliers, the Sahelian countries, were unable to meet its demand for beef. World meat prices began to rise in late 1976, however, and it is unlikely that in the next five to ten years Ivory Coast will be able to rely on the world market to the degree it did in 1976 without incurring a large outflow of foreign exchange.

The Ivorian Red Meat Supply: A Summary

Table 8 summarizes the statistics on the Ivorian red meat supply in 1976; it shows that beef is by far the most widely consumed red meat in Ivory Coast, accounting for nearly three-fourths of the total supply. In 1976, meat from small ruminants made up 18 percent of the total, and pork accounted for 9 percent. The bulk of the meat supply is imported. Domestic production accounted for only 26 percent of total red meat consumption in 1976, while imports of live animals from the Sahelian countries supplied about 45 percent; imports of frozen and chilled meat accounted for the remaining 29 percent.

Table 9 presents changes in the Ivorian beef supply in recent years. The table shows that while the total quantity of beef consumed was the same in 1970 and 1976 (approximately 43,600 tons), the pattern of supply changed considerably between these two years. The share of the total supply met by domestic production increased gradually from 11 percent to 16 percent over the period. The major change, however, was the large increase in the relative share of frozen and chilled meat imports. From supplying an average of 3 percent of the total beef supply during the period 1970-74, chilled and frozen beef imports increased to 16 percent of the total supply in 1975 and 38 percent in 1976. The proportion of the total supply met by live animal imports from the Sahelian countries fell from 84 percent in the 1970-74 period to 66 percent in 1975 and 46 percent in 1976.

The massive increase in frozen meat imports in 1975 and 1976 represented the opening of the Ivorian market to non-West African suppliers. Until 1975, 99.7 percent of the Ivorian beef supply was met by domestic production and imports of livestock and meat from neighboring Sahelian countries. By 1976, however, 37.6 percent of the total supply came from outside the West African region: 29.4 percent from South America, 6.2

TABLE 8

ESTIMATED IVORIAN RED MEAT SUPPLY IN 1976
(tons of meat and edible offals)

Type of Meat	Domestic Production		Imports: Live Animals		Imports: Meat		Total	
	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent
Beef	6,923	11.6	20,076	33.6	16,611	27.8	43,610	73.0
Mutton/Goat Meat	3,600[a]	6.0	7,000[b]	11.7	339	0.6	10,939	18.3
Pork	5,150[a]	8.6	--	--	47	0.1	5,197	8.7
Horse	--	--	--	--	33	--	33	--
Total	15,673	26.2	27,076	45.3	17,030	28.5	59,779	100.0

SOURCES: Tables 3, 6, 7 and text.

[a] Domestic goat, mutton, and pork production estimated at three percent above their 1975 levels.

[b] Author's estimate based on examination of statistics from exporting countries (see p. 157).

TABLE 9

THE IVORIAN BEEF SUPPLY: 1970-76 (TONS OF MEAT AND EDIBLE OFFALS)

	Imports						Domestic Production		- Total[a]	
	Live Animals		Fresh, Chilled, and Frozen Meat		Total Imports					
Year	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent
1970	37,448	85.8	1,477	3.4	38.925	89.2	4,700	10.8	43,625	100.0
1971	32,761	83.1	1,405	3.6	34,166	86.7	5,243	13.3	39,409	100.0
1972	37,715	84.9	1,205	2.7	38,920	87.6	5,507	12.4	44,426	100.0
1973	38,909	85.0	1,077	2.3	39,986	87.3	5,796	12.7	45,782	100.0
1974	33,885	81.7	1,243	3.0	35,128	84.7	6,349	15.3	41,477	100.0
1975	24,317	65.5	6,093	16.4	30,410	82.0	6,689	18.0	37,100	100.0
1976	20,076	46.0	16,611	38.1	36,687	84.1	6,923	15.9	43,610	100.0

SOURCES: Tables 2, 6, and 7.

[a] Totals may differ slightly from sum of subtotals due to rounding.

percent from Europe, and 2.0 percent from Southern and East Africa. The total recorded amount of non-West African meat imported in 1976 equaled 16,424 tons. This was the equivalent of roughly 91,880 head of Sahelain cattle.[1]

The Ivorian market for cattle and beef thus changed radically between 1974 and 1976. Meat imports from Latin America and Europe began to play an important role in supplying Ivory Coast with meat, and the Sahelian states faced the spectre of having to compete with non-West African meat exporters for a share of the Ivorian market. Ivory Coast itself was trying to increase domestic livestock production during this period in order to reduce the country's reliance on livestock and meat imports from all sources. Within the context of this changing supply pattern, the question of the efficiency of the traditional cattle and meat marketing system became especially important. Was inefficiency in the traditional marketing system partly to blame for the Sahelian countries' declining share of the Ivorian market? Did exploitative livestock traders offer extremely low prices to Ivorian cattle producers, thus discouraging domestic production? Could the traditional marketing system adapt to the new supply conditions, or were new marketing structures needed? The micro-economic-level research described in the following sections of this paper was aimed at answering these questions.

MARKET ORGANIZATION: A CONSTRAINT TO DEVELOPMENT?

Many government officials and foreign advisors in West Africa believe that the traditional organization of cattle and meat marketing prevents efficient market operation. Three problems are alleged to exist: 1) that a large number of the market participants, particularly intermediaries, provides no useful services to buyers or sellers and are unnecessary "parasites" on the system; 2) that traders and intermediaries sometimes conspire to restrict the number of animals sold, thus artificially raising prices; 3) that many market participants, particularly butchers, lack the basic business skills needed for expansion of the trade. Most West African governments have called for reorganization of the cattle trade in recent years. For example, the Entente states (Ivory Coast, Togo, Benin, Niger, and Upper Volta) have signed agreements (5) aimed at guaranteeing more state control over the trade. Ghana has gone even further, replacing the traditional marketing system with a state monopoly.

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[1] Based on an average carcass weight of 143 kg plus edible offals equal to 25 percent of carcass weight. (See Table 6.)

This study examined the need for market reorganization by looking at the structure, conduct, and performance of the current marketing system. Market structure was evaluated by measuring the degree of buyer and seller concentration in the Abidjan and Bouaké markets. Market conduct was examined by studying the roles played by different agents in the marketing system and by examining the incidence of collusion. Market performance was judged by examining the net margins of butchers and traders. The research showed that the traditional marketing system is fairly competitive. Market concentration among both buyers and sellers is, in most instances, low enough to make collusive agreements inherently unstable. Collusion among intermediaries to restrict the number of animals sold appears rare, although intermediaries sometimes do collude in deciding to whom they will sell. The research also showed that most intermediaries provide important services to buyers and sellers, including guaranteeing credit, facilitating sales, and speeding the flow of market information. The research also showed that the net margins of butchers and cattle traders are modest, together accounting for about 14 percent of the retail price of beef in Abidjan and Bouaké.

Market Structure

Economic theory suggests that a high degree of market concentration is often associated with non-competitive pricing arrangements. While a high degree of market concentration does not prove the existence of collusive pricing in a market, there are strong theoretical reasons to believe that the presence of few sellers in a market, each having a large market share, is often associated with non-competitive pricing.[1] In West Africa, it is often alleged that a few large cattle merchants and intermediaries control such a high proportion of sales in certain markets that they can restrict the number of animals sold, thereby forcing up prices and earning monopoly profits.

Data collected during the field studies in Bouaké and Abidjan can be used to measure the degree of market concentration among major intermediaries in these two cities and to draw inferences about the likely degree of competition among them. Concentration ratios, which measure the proportion of total sales handled by a given person, were calculated for intermediaries in both Abidjan and Bouaké, based on several month's data.[2] Table 10 summarizes the results.

Table 10 indicates that in Abidjan a large number of sellers were present and market shares were typically small. Even in the month of highest seller concentration, the four largest intermediaries in Abidjan controlled only 36 percent of total sales and the largest eight controlled only 56 percent. Most authors agree that with such a low degree of market concentration it would be extremely difficult to maintain collusive agreements aimed at restricting sales (2, pp. 112-24). In Bouaké, there were fewer total sellers in the market, and market shares were larger. During the month of highest concentration, the four largest intermediaries controlled nearly 70 percent of total sales. During most months, however, the market share of the four largest intermediaries was between 50 and 60 percent. Although market concentration was higher in Bouaké than in Abidjan, in most months it was still low enough to make collusive agreements inherently unstable. Furthermore, most intermediaries received the largest part of their income from a fixed commission which was paid to them (by the purchaser) for every animal they sold. Since the commission did not vary with the price of the animal, intermediaries usually had an interest in maximizing, not restricting, the number of cattle sold.

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[1] These theoretical arguments are discussed in 27, pp. 124-26.

[2] See 27, pp. 128-31 for details of how these concentration ratios were calculated.

TABLE 10

CONCENTRATION RATIOS FOR LARGE AND MEDIUM-SCALE INTERMEDIARIES IN ABIDJAN AND BOUAKE[a]

Number of Sellers	Percentage of Total Sales	
	Abidjan	Bouaké
	Entire Period of Observation	
	(Dec., 1976-June, 1977)	(Sept., 1976-June, 1977)
Largest 1	6.8	20.1
Largest 4	23.2	45.3
Largest 8	37.1	63.5
Largest 20	64.4	87.8
Total Number of Sellers	140	62
	Month of Higest Concentration[b]	
	(February, 1977)	(January, 1977)
Largest 1	12.4	23.6
Largest 4	35.7	69.0
Largest 8	55.6	86.7
Largest 20	76.4	--
Total Number of Sellers	62	17
	Month of Lowest Concentration	
	(May, 1977)	(November, 1976)
Largest 1	7.6	12.4
Largest 4	26.6	43.6
Largest 8	44.4	64.5
Largest 20	77.0	83.3
Total Number of Sellers	61	24

[a] Includes intermediaries and merchants who sold without the aid of an intermediary.

[b] Degree of concentration measured by the percentage of total sales handled by the four largest intermediaries.

Therefore, even in the months of highest seller concentration in Bouaké, when it would have been easiest for intermediaries to collude to restrict sales, it is not clear that it would have been in their interest to do so.

Concentration among butchers in Abidjan appeared to be at roughly the same level as that among intermediaries in Abidjan, although the data necessary to calculate concentration ratios for most butchers were unavailable. About fifty-five butchers bought and slaughtered cattle in Abidjan in early 1977, and the market share of the largest butcher was approximately 15 percent. In Bouaké, market concentration among butchers was very low. Approximately forty-five butchers were active in the Bouaké cattle market in 1976-77; no butcher slaughtered more than two head of cattle per day, and most slaughtered only one. On the buyers' side, the Bouaké cattle market therefore approached the perfectly competitive model of many buyers, each with equally small market shares.

In summary, the data on market structure suggest that the scope for collusive behavior by buyers and sellers of cattle in Abidjan and Bouaké was quite limited. The degree to which sellers could artifically raise prices was further limited by the availability to butchers of inexpensive frozen beef. If butchers found cattle prices too high, they could sell frozen meat instead of slaughtering cattle.

Market Conduct

Market conduct was examined by studying the roles played by different agents in the marketing system and by noting the incidence of collusion. A detailed description of the roles of different marketing agents is presented elsewhere (27, Chapters 3 and 4). The discussion below concentrates on the role of intermediaries, the market agents most frequently criticized as being "parasites" on the marketing system, and on the organization of the indigenous training systems for butchers and traders. The discussion also deals with the types and incidence of collusion observed in Bouaké and Abidjan.

The research showed that the term "intermediary" covers a wide variety of marketing agents, ranging from large-scale cattle brokers to small-scale traders. In its braodest sense, the work refers to anyone who comes between a northern cattle merchant and a southern butcher. In a narrower sense, however, the word refers only to cattle brokers, who arrange to sell a cattle merchant's animals, but do not actually buy the animals themselves. Most intermediaries (especially large-scale intermediaries) play important roles in helping northern cattle merchants sell their animals in unfamiliar markets, transmitting market information, and guaranteeing the credit of local buyers. Roughly 25 percent of all cattle sales in Bouaké and 50 percent of all sales in Abidjan are on credit, and the bulk of this credit is guaranteed by intermediaries. If authorities tried to eliminate intermediaries from the marketing system (as is sometimes advocated) without creating an organization to replace the intermediaries' credit function, a severe credit constraint would arise in the Bouaké and Abidjan cattle markets. A reduction in the availability of credit of this sort would greatly increase the working capital required to buy and slaughter cattle. This, in turn, would make it more difficult to enter the butchering trade and would probably force some butchers out of business, thus reducing competition in the trade and probably leading to higher meat prices.

Many butchers, however, complain about the large number of small-scale intermediaries in the Abidjan and Bouaké markets. Small-scale intermediaries handle only a few animals at a time and typically do not extend or guarantee credit. Usually they restrict their activities to buying animals on credit from large-scale intermediaries and reselling the animals to butchers for a profit. Interview with butchers and traders in Abidjan and Bouaké indicated that the number of small-scale intermediaries in these markets increased substantially following the Sahelian drought of the late 1960s and early 1970s. The research showed that in the short run, the activities of these small-scale intermediaries may indeed raise the price of cattle. Their activities also have the effect, however, of speeding up the sale of cattle in the south, thereby increasing the rate of capital rotation of northern merchants.

This, in turn, raises the profitability of the north-south cattle trade (See 27, pp. 138-40). The higher profitability encourages more merchants to ship animals south and may, in the long run, lead to lower prices. Thus, even where the charge of intermediaries being "parasites" seems strongest, it is far from proven.

Cattle and meat marketing require specialized knowledge, and the traditional marketing system has developed indigenous training programs to impart this knowledge to people entering the trade. Most cattle merchants, large-scale intermediaries, and butchers spend several years as assistants or apprentices before entering the trade themselves. For example, butchers interviewed in Bouaké spent an average of 7.5 years as apprentices before becoming independent butchers. During their apprenticeships, young butchers and cattle merchants learn the fundamentals of cattle and meat marketing and accumulate the capital needed to enter the trade. There is, therefore, little evidence that merchants and butchers need special government training programs to teach them business fundamentals. Most cattle traders and butchers are highly experienced individuals having a detailed knowledge of their profession.

In over a year's observation of the Bouaké and Abidjan cattle markets, the investigator never observed collusion among intermediaries to restrict the number of cattle sold in order to force up prices, nor among butchers to restrict the volume of meat sold. Butchers, in fact, often complained about their inability to form a collusive bloc to deal with the intermediaries. Intermediaries, for their part, usually received the majority of their income from a fixed commission on every animal sold, and therefore has an interest in maximizing, not restricting, the number of animals sold.

Intermediaries would sometimes collude in deciding to whom they would sell, but not on the volume of sales. Intermediaries sometimes refused to sell to buyers who had defaulted on previous purchases on credit, in order to try to force repayment of the debt. Butchers also claimed that large-scale intermediaries would sometimes refuse to deal directly with butchers, preferring to pass through smaller scale intermediaries, who were often related to the large intermediaries. This occasional refusal by some large-scale intermediaries to deal directly with butchers led to many of the charges of "parasitism" that were discussed above.

Market Performance

Market performance was examined by looking at butchers' and traders' net margins, the net returns to these agents' capital and labor. Although the gross margin[1] of merchants who ship cattle to Ivory Coast from Mali and Upper Volta is typically large, most of this gross margin is attributable to transport costs and export taxes, not profits. The merchants' profits typically account for between 4 and 9 percent of the final sale price of cattle shipped to Abidjan and Bouaké. Rates of return to capital of traders who shipped cattle to Bouaké in 1976-77 varied between 16 and 30 percent per year, within the range of the accepted opportunity cost of capital in West Africa. Rates of return to capital of merchants who shipped cattle to Abidjan in 1976-77 were higher, but the high returns were apparently due to a transportation bottleneck that restricted cattle shipments to Abidjan and to the high risk of shipping cattle to Abidjan (due to the volatility of Abidjan cattle prices), not to collusion on the part of cattle merchants.

Similarly, the net margins of class 2 (traditional) butchers in Bouaké and Abidjan were fairly low, accounting for between 8 and 12 percent of the retail price of beef. These margins were considerably below those earned by class 1 (European-style) butchers in Ivory Coast.

Table 11 shows how much of the retail price of beef in Abidjan in 1977 was attributable to different costs. The figures are based on a 150-kg carcass weight animal purchased in Ouagadougou and shipped to Abidjan by rail.[2] Table 11 indicates that although the gross marketing

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[1] The gross margin is the difference between the producer price and the retail price.

[2] See 27, pp. 428-30, for details of how the figures in Table 11 were calculated. During 1976-77 Ouagadougou was the single most important source of cattle sold in Abidjan, accounting for about 44 percent of the total.

TABLE 11

EVOLUTION OF THE COST OF BEEF AND OFFALS SOLD RETAIL IN ABIDJAN

Item	Percent of Final Sale Price
1. Purchase of animal in Ouagadougou	46.8
2. Labor	
Shipping Cattle	0.5
Slaughter	0.6
Total Labor	1.1
3. Intermediaries' commissions & margins	1.9
4. Taxes and licenses	
Ivory Coast	4.3
Upper Volta	8.4
Total Taxes	12.7
5. Transport of cattle	
Transport fees	6.1
Shrinkage	7.0
Losses and forced sales	1.5
Total Transport	14.6
6. Selling costs of meat	
Transport, stall rental, & Labor[a]	4.4
Wastage (bone)	1.0
Losses due to condemnations & default on credit sales	0.8
Total Selling Costs	6.2
7. Profits	
Cattle trader	5.0
Wholesale-retail butcher	7.5
Vendor of fifth quarter	4.1
Total Profits	16.6

[a] Includes an estimated total cost of selling offals (stall rental, labor, transport, and wastage) of 2,500 CFAF per animal.

margin accounted for over half the retail price of beef and offals in Abidjan, only about 19 percent of the retail price was attributable to total profits. Cattle traders' profits accounted for about 5 percent of the retail price of beef in Abidjan, and the profits of wholesale and retail butchers accounted for less than 8 percent. Intermediaries' commissions, which officials often decry as inflationary, accounted for only about 2 percent. Therefore, even if the profits of all butchers, traders, and intermediaries were reduced to zero, the retail price of beef in Abidjan would fall by less than 20 percent. In contrast, transport costs (including the high implicit cost of weight loss en route) accounted for about 15 percent of the retail price of beef, while taxes and licenses accounted for about 13 percent.

In summary, the data on market structure, function, and performance seem to indicate that the traditional cattle and meat marketing system works fairly efficiently. The data lend little support to the assertions that a few intermediaries and traders exercise monopoly power over major markets or that traders profits are exorbitant.

MARKET INFRASTRUCTURE NEEDS[1]

Most cattle marketing projects undertaken by the Ivorian government and donor agencies have emphasized improving market infrastructure, e.g., by providing cattle scales to markets and by constructing modern abattoirs. Planners seem to hope that by duplicating the structure of cattle markets in developed countries, the efficiency of those markets can be duplicated. Some officials also seem to hope that by moving to the sale of cattle on a per-kg basis it will be easier for the government to set cattle prices. Most marketing projects have therefore emphasized changing the structure of the marketing system to make it correspond more closely to the market structure in developed countries rather than looking at the functions a marketing system must perform, identifying the infrastructure constraints that prevent the current system from performing those tasks efficiently, and moving to relax these constraints.

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[1] This section deals exclusively with the infrastructure needs of cattle markets and abattoirs in Ivory Coast. Needs for improved transportation infrastructure are discussed in the following section.

As a result of the this "structuralist" approach to market reform, the infrastructure provided by several marketing projects has not corresponded to the needs of the marketing system. For example, plans have called for installing cattle scales in major cattle markets and encouraging the sale of cattle on a per-kg basis, even though there is little evidence that a lack of scales has hindered efficient market operation. In fact, cattle and meat prices in Ivory Coast fluctuate seasonally and from day to day in a manner entirely consistent with fluctuations in supply and demand, and the distribution of prices per kg. of cattle sold on sight in Abidjan and Bouaké is tightly clustered about the mean, indicating that butchers accurately estimate carcass weights without using scales.[1] Furthermore, in markets where cattle scales have been installed, butchers and traders have refused to use them.[2]

There are, however, serious market infrastructure constraints to cattle and meat marketing in Ivory Coast (particularly in Abidjan) that marketing projects have not addressed. These involve inadequate slaughterhouses in Abidjan and Bouaké, the lack of grazing space near the Abidjan market, and poor unloading facilities for cattle. Each is discussed briefly below.

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[1] For zebu males with carcass weights of between 130 and 160 kg sold in Bouaké during the study period, the standard deviation of average monthly prices per kg was only 8.5 percent of the mean. In other words, 68 percent of all prices fell within ± 8.5 percent of the mean. Furthermore, not all of the variation around the mean was random; some was due to daily fluctuations in supply and demand and to differences in the degree of finish of the animals.

[2] There are three main reasons why butchers and traders in these markets are reluctant to sell animals by weight. First, it is difficult to weigh cattle that are not used to being handled, and the risk of injury, either to the animals or to the person trying to weigh them, is significant. Second, the scales are often out of adjustment, giving inaccurate weights. Third, differences in gut fill among animals can lead to significant fluctuations in liveweights.

The Abidjan abattoir, originally constructed as modern, assembly-line slaughterhouse, has not been maintained, and currently, conditions of slaughter are extremely poor. Few carcass hoists in the abattoir still function, so animals are gutted on the floor, where they lie surrounded by blood and intestinal contents. Extensive refurbishing of the Abidjan abattoir is needed to insure the basic cleanliness of slaughter facilities in the Ivorian capital. In contrast, the Bouaké abattoir is an extremely simple structure (an open-sided building with cement floors and hand-operated carcass hoists), and conditions during slaughter in Bouaké are much more hygienic than in Abidjan. The Bouaké abattoir, however, was built in 1946 and is now too small to handle adequately the number of animals passing through it. It needs replacing, preferably by a structure designed along the lines of the current abattoir.

A second major infrastructure constraint to cattle marketing in Ivory Coast is a lack of grazing space around the abattoir and cattle market in Abidjan, Ivory Coast's largest market for beef. The lack of grazing prevents butchers and merchants from holding a buffer stock of animals to smooth out supply fluctuations. Since rail shipments of cattle to Abidjan are irregular, the supply of cattle in Abidjan varies widely from day to day. With no buffer stock to absorb some of this variation, prices there are volatile. The instability of cattle prices in Abidjan leads to a higher rate of default on debts by butchers and more fluctuant meat prices than in Bouaké, where cattle can be held as a hedge against supply fluctuations. As a result, Abidjan is a riskier market for northern cattle merchants than is Bouaké.[1]

A third problem at the Abidjan cattle market is that inadequate unloading facilities prevent cattle from being unloaded from rail cars at night. As a result, cattle arriving in Abidjan often must wait ten hours or more before they can be unloaded. Most cattle arriving in Abidjan by rail have already spent two to three days en route without food or water. The additional ten-hour wait in Abidjan at the end of the journey, when the animals are very weak from the trip, significantly increases mortality and weight losses of cattle shipped by rail.

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[1] Similar problems due to a lack of grazing are developing on a smaller scale at the cattle market in Man.

Given the difficulties of holding cattle in Abidjan and the poor condition of the Abidjan abattoir, officials should seriously consider moving the cattle market-abattoir complex out of the industrial zone of Port Bouët to an area where adequate grazing and water are available. Unless the market is moved or unless means are found to provide forage economically to the cattle at the present location, many of the current problems of cattle marketing in Abidjan (e.g., the high rate of default on debts) are likely to continue.

Even if the Abidjan abattoir is not moved from its present location, it will eventually become necessary to refurbish or rebuild it. When refurbishing the Abidjan abattoir or building new abattoirs in other cities, officials should keep two principles in mind. First, they should avoid overcapitalizing the slaughterhouses, i.e., replacing inexpensive labor with expensive imported capital equipment. Most modern abattoirs constructed in Africa are designed after abattoirs in developed countries, where capital is relatively cheap and labor is relatively expensive. In developing countries, however, the relative prices of capital and labor are just the reverse. If officials contract for the construction of abattoirs with companies that simply copy the plans of European or North American slaughterhouses rather than try to adapt these plans to African price conditions, the cost of slaughtering probably will be raised substantially above what it otherwise would have been, and many of the laborers currently involved in slaughtering will be thrown out of work.

The second point to be kept in mind is that the equipment used in the abattoirs should be simple and easy to repair. Equipment like power hoists and electric scales are likely to break down often when given heavy use by relatively untrained abattoir personnel. Simple manual equipment for which spare parts can be made locally, is likely to be both cheaper and more reliable than more complicated power equipment.

A "functional" approach to improving market infrastructure may prove more valuable than the "structural" approach used widely up to now. The goal of improved market infrastructure is to help the marketing system efficiently perform its tasks of distributing cattle and meat. Given the problems facing cattle merchants and butchers in Ivory Coast, the infrastructure needs may not always be the same as those in developed countries. Plans for improving market infrastructure should therefore be preceded by an analysis of the critical constraints to marketing, and the improvements in infrastructure should be designed to relax those constraints.

PROBLEMS AND COSTS OF TRANSPORTING CATTLE

Cattle marketing in West Africa is characterized by long distances between the areas of livestock production in the Sahelian countries and the major meat-consuming regions in the coastal countries. Because of the distances involved, transport costs for livestock become important components of the retail price of meat in the coastal areas. Reducing transport costs for cattle could therefore benefit both producers and consumers of beef considerably. This section examines the costs of alternative means of transporting cattle in West Africa and discusses some of the policy issues involved in livestock transport.

Current Pattern of Cattle Transport

Cattle travel to market in West Africa on hoof, by truck, by train, or by some combination of these methods. Trekking remains the most common means of transport, with almost all animals except those from government feedlots trekking at least part of the way to market. Rail transport is commonly used to ship cattle very long distances (e.g., from Ouagadougou to Abidjan) and to ship cattle shorter distances during the dry season, when grazing along trek routes is sparse. Long-distance trucking of cattle all the way from livestock-producing areas in the north to major consumption markets in the south is used very rarely, but intermediate-distance trucking of cattle within the forest zone of Ivory Coast is fairly common. Many observers feel that the heavy reliance placed on trekking results in several problems, including high mortality and weight losses during shipment and extensive crop damage to fields along major trek routes. In order to reduce these alleged problems, the Ivorian government has advocated increased use of truck and rail transport for cattle.

Transport Costs

The cost of transporting cattle includes direct cash costs, such as truck rental and wages of drovers; indirect (non-cash) private costs, such as mortality and weight losses during shipment; and social costs, such as the value of damaged crops for which no compensation is paid. This subsection outlines these costs, evaluating the advantages and disadvantages of transporting cattle by trek, truck, and rail.

Trekking.-- Trekking is a relatively inexpensive means of transporting cattle within the Sudanese and Guinea savanna zones. Most cattle merchants prefer trekking to other means of transport because trekking requires a low cash outlay and allows the merchant more flexibility than trucking or rail transport in timing the arrival of his herd to coincide with favorable market conditions. Typically a merchant whose cattle are trekked to market arrives at the market of destination a few days before the scheduled arrival of this herd in order to contact an intermediary and to evaluate market conditions. If prices are high, the merchant sends word to his drovers to rush the cattle to market so that he can benefit from the high prices. If prices are low, he tells the drovers to slow down and wait for market conditions to improve. When shipping cattle by truck or rail, merchants must often wait several days for trucks or train cars to become available, and it is therefore more difficult to time the animals arrival to correspond with favorable market conditions.

The low cash outlay required for trekking is illustrated in Table 12, which compares the cost of trekking cattle to Bouaké from Tingrela, on the Mali - Ivory Coast border, with the cost of trucking them along the same route. Table 12 indicates that for a cash outlay of 86,000 CFA F

TABLE 12

COST OF TRANSPORTING FIFTY HEAD OF CATTLE FROM TINGRELA OR BOUNDIALI TO BOUAKE BY TREKKING AND BY TRUCK: 1976-77 (in CFAF)

Expense	Trek		Truck	
	Total	Per Animal	Total	Per Animal
1. Salary of drovers	3 @ 10,000 = 30,000	600	2 @ 5,000 = 10,000	200
2. Food for drovers	15,000	300	—	—
3. Return trip for drovers	3 @ 2,500 = 7,500	150	2 @ 2,500 = 5,000	100
4. Round-trip for owner	5,000	100	5,000	100
5. Food for owner in Bouaké 7 days @ 200 CFAF/day	1,400	28	1,400	28
6. Health certificate	2,000	40	2,000	40
7. Vaccination	1,750	35	1,750	35
8. Amortization of cattle merchant's license	12,100	242	12,100	242
9. Indemnity for damaged fields	475	10	—	—
10. Loss of animals	1.0% of 50 animals @ 40,000 CFAF per animal = 20,000	400	1.6% of 50 animals @ 40,000 CFAF per animal = 32,000	640
11. Forced sales	0.6% of 50 animals @ 20,000 CFAF loss per animal = 6,000	120	0.6% of 50 animals @ 20,000 CFAF loss per animal = 6,000	120
12. Truck rental	—	—	2 trucks @ 87,500 CFAF each = 175,000	3,500

TABLE 12 CONTINUED

Expense	Trek		Truck Transport	
	Total	Per Animal	Total	Per Animal
13. Unofficial costs	—	—	10,000	200
14. Cattle market tax: Bouaké	10,000	200	10,000	200
15. Gift to landlord	0-5,000	0-100	0-5,000	0-100
Total Cost (excluding weight loss)	111,225 - 116,225	2,225 - 2,325	270,250 - 275,250	5,405 - 5,505
Days in transit from:				
Boundiali		25		1
Tingrela		30		1

(total costs excluding weight losses, losses of animals, and forced sales) a merchant could trek fifty head of cattle from Tingrela to Bouaké and sell them in the Bouaké market. To ship the same animals by truck and sell them in the Bouaké market required a cash outlay nearly three times as large, 233,000 CFA F. Time in transit, however, was only one day by truck compared with 30 days by trek.

The indirect costs of trekking (losses of animals en route, forced sales, weight losses, and crop damage) are typically low in the Sudanese and Guinea savanna zones. Interviews conducted in 1976-77 with the chief drovers of thirty herds trekked to Bouaké indicated that only 1 percent of their animals were lost en route, and that mortality per se among trekked animals was extremely low.[1] Forced sales (sales at a loss of animals that were too ill, too injured, or too exhausted to continue the trip) were likewise extremely low, accounting for 0.6 percent of the animals trekked to Bouaké. (See 27, pp. 218-20 for details.) Weight losses during trekking are extremely variable, depending, among other things, on the season, the state of health of the animals, and the speed at which the cattle are trekked. Data on weight losses are scarce, but those that do exist suggest that weight losses during trekking may not be as high as is sometimes alleged. Weighings of cattle trekked between Sikasso, Mali and Bouaké during the rainy season indicated that herds can actually gain weight when trekked during the rainy season (27, pp. 221-24). Data from Upper Volta (18) show that even during the dry season, cattle do not always lose weight during trekking.

Government officials in Ivory Coast often cite crop damage by trade herds as a major social cost of trekking. Data collected in Bouaké, however, indicate that cost of crop damage per animal trekked to market is extremely low, on the order of 10 CFA F. Even if the incidence of crop damage were several times higher than indicated by these data, it would not be high enough, from an economic standpoint, to justify trucking.[1]

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[1] Most animals lost during trekking simply became separated from the herds and were lost in the surrounding countryside. Only mortality losses represented net losses to society. Animals lost in the bush during trekking represent losses to cattle merchants, but not to society as a whole, because someone presumably found the lost animals and either raised them or salughtered them.

The major disadvantage of trekking, from a merchant's point of view, is that it takes longer than trucking or rail shipment; therefore, a merchant cannot rotate his capital as quickly as with other means of transport. Nevertheless, during the study period, trekking cattle to market was generally more profitable than trucking them, even taking into account the slower rate of capital rotation involved.

Trucking.-- Long-distance trucking is often advocated as a solution to the problems of weight loss and crop damage associated with trekking. Data collected during the study (as typified by the figures presented in Table 12), however, indicate that trucking is an expensive way of moving cattle in the Sudanese and Guinea savanna zones. The high cost of trucking explains why few merchants currently truck cattle long distances in Ivory Coast. Trucking is competitive within the forest zone, however, where trekking is difficult (and in some areas forbidden), and trucking within the forest zone is common.

Several factors work against long-distance trucking of cattle in Ivory Coast. Truck rental rates per animal are high because truckers can usually earn more money hauling cargoes with higher weight-to-volume ratio s than cattle. Truckers therefore regard cattle as a backhaul cargo of last resort, a cargo that pays only some of the costs of the return trip south.[2] In 1977 truck rentals fees accounted for 75 percent of cash cost and 65 percent of the total cost (excluding weight losses) of trucking cattle between Tingrela and Bouaké. Other major costs of trucking are the bribes and "gifts" that truckers and merchants are sometimes forced to pay police and customs officials along the route. These costs are less important for trekked herds than for trucked herds because drovers can often avoid police checkpoints by trekking their animals away from the main roads.

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[1] An alternative means of dealing with the problem of crop damage is discussed below in the section on policy recommendations.

[2] Data on transport costs in Ivory Coast collected by SETEC International (21) indicate that in 1976 it cost roughly 117,000 CFA F to operate an 18-ton truck (capable of hauling 25 head of cattle) between Tingrela and Bouaké. Table 12 shows that this was 29,500 CFA F more than could be earned hauling cattle along this route.

The indirect costs of mortality and weight losses during trucking also appear to substantial. Because of the small number of cattle shipped long distances by truck in Ivory Coast, it proved impossible during the study to empirically determine the mortality rate for trucked cattle. Cattle traders interviewed in Abidjan and Bouaké, however, generally stated that about twice as many animals were lost during trucking as during trekking. Weighings of cattle trucked to Abidjan from Niono, Mali and from Ferkéssédougou, Ivory Coast indicated that net carcass weight losses during trucking were fairly high, about 2.7 percent per day in transit (27, pp. 242-43).

The main advantages of long-distance trucking of cattle are that it allows merchants to react quickly to shortages of cattle in the consumption markets (if they can quickly find trucks to transport their animals) and it permits a more rapid rotation of capital. For example, instead of trekking his animals for thirty days between Tingrela and Bouaké, a merchant can truck them to Bouaké in a single day. Even if it takes him a week to assemble the herd in Tingrela, three days to find a truck, a week to sell the animals in Bouaké, and a day to return to Tingrela, his rate of capital rotation will be two and one-half times that of a merchant who trekked his cattle to market (eighteen days versus forty-five days). During most of the study period, however, the price differential between markets was not high enough to make trucking more profitable than trekking, even taking into account the faster rate of capital rotation. Long-distance trucking was therefore used only when price differentials between markets were unusually high.

The above discussion applies to trucking costs within the Sudanese and Guinea savanna zones. Within the forest zone (i.e., the area south of Bouaké) trekking cattle is difficult because of dense vegetation and heavy tsetse infestation, and in some areas trekking is outlawed. The real costs of trekking are therefore higher in the forest zone than in the savanna. Trucking costs, on the other hand, are generally lower in the forest zone than in the savanna because most of the main roads within the forest zone are paved. Trucking therefore becomes a viable alternative to trekking in the forest zone, and intermediate-distance trucking of cattle within this zone is common.

Rail Shipment.-- Almost all cattle sold in Abidjan arrive by train. Some trek part of the way to Abidjan before boarding the train (e.g., from Mali to Ferkéssédougou); others, particularly those from Upper Volta, travel the entire distance by rail. Rail shipment is more costly per trip than trekking, but allows cattle to be shipped longer distances, particularly during the dry season, than trekking would allow. Rail transport also permits traders to rotate their capital more quickly than trekking does.

Table 13 shows the typical costs (excluding weight losses) of exporting cattle by rail from Ouagadougou to Abidjan in 1976. The table shows that of the total cost of about 14,000 CFA F per animal, over half was attributable to taxes and license fees. By far the largest of these was the Voltaic export tax of 6,519 CFA F per head. Rail transport charges accounted for about 30 percent of the cost of exporting cattle, and other charges made up the remaining 20 percent. Although rail transport costs are not the single most important cost of exporting cattle from Ouagadougou to Abidjan, they are, nonetheless, a crucial determinant of cattle prices in both cities.

There are three major problems with rail shipment of cattle in Ivory Coast and Upper Volta. First, delays in loading, unloading, and en route result in cattle spending a long time in the poorly ventilated rail cars without food or water. For example, the research showed that on the average cattle shipped from Ouagadougou to Abidjan spend 3.5 days between the time they are loaded in the cars in Ouagadougou and the time they are unloaded in Abidjan. During this time they receive neither food nor water. The results are heavy shrinkage and losses due to mortality. The data indicate that cattle shipped from Ouagadougou to Abidjan lose about 9 percent of their original carcass weights en route. Tissue shrinkage

TABLE 13

COST OF TRANSPORTING FIFTY HEAD OF CATTLE FROM OUAGADOUGOU TO ABIDJAN BY RAIL (IN CFAF)

Expense		Total Cost	Cost per Animal
1.	Marking animals to denote ownership (Ouagadougou)	500	10
2.	Landlord's commission in Ouagadougou	12,500	250
3.	Payment to herders to watch animals before shipment	7,500	150
4.	Export license	4,150	83
5.	Veterinary inspection of animals	7,500	150
6.	Certificate of origin (100 CFAF per herd)	100	2
7.	Salary of drovers 2 @ 5,000 CFAF	10,000	200
8.	Food for drovers 2 @ 2,000 CFAF	4,000	80
9.	Authorization to export	200	4
10.	Voltaic export tax 6,519 CFAF per animal	325,950	6,519
11.	Rail transport 2 H12 cars @ 104,666 CFAF	209,332	4,187
	Straw for cars	8,000	160
	Loading of cars 2 @ 750 CFAF	1,500	30
	Unloading of cars 2 @ 500 CFAF	1,000	20
	Other charges	0-40,000	0-800
12.	Loss of animals 1.6% of 50 animals .8% thrown out for loss of 54,000 CFAF per head	21,600	
	.8% sold at an average loss of 27,000 CFAF per load	10,800	
	Total loss: mortality	32,400	648
13.	Forced Sales 3% of 50 animals at an average loss of 18,000 CFAF per animal	27,000	540
14.	Market tax: Abidjan	25,000	500
15.	Gift to the landlord	0-5,000	0-100
	Total (excluding weight losses)	676,632-721,632	13,533-14,433
	Days in transit	2-5	

SOURCE: Field study results; Larry Herman, personal communication; and Larry Herman, "Cattle and Meat Marketing in Upper Volta," Report to U.S.A.I.D., (Ann Arbor: 1977), pp. 119-40.

is the single largest cost, excluding export taxes, of shipping cattle between Ouagadougou and Abidjan, costing about 5,700 CFA F per head.[1] Mortality losses and forced sales, while significant, are less important than shrinkage losses, costing about 1,200 CFA F per head. Roughly 1.6 percent of all cattle shipped between Ouagadougou and Abidjan die en route (See Table 14). Mortality losses only become important when cattle spend more than two days in the train cars; therefore, very few cattle shipped by rail within Ivory Coast die en route.

The second major problem of rail shipment is that the cars used by the RAN[2] to ship cattle are boxcar-style wagons with very poor ventilation. As a result, the cars become very hot inside, and this exacerbates the mortality and weight losses en route.

The third problem of rail transport is a seasonal shortage of rail cars during the peak months of the cattle trade (September to February). The shortage often forces merchants to wait a week or more for cars to ship cattle south. The transportation bottleneck not only reduces the number of cattle that can be shipped to Abidjan; it significantly raises the price of moving cattle south, as merchants incur additional costs as their herds wait at the railroad loading points for cars to become available. These costs are estimated at roughly 124 CFA F per animal per day, or 6,200 CFA F per day for a herd of fifty head (27, pp. 225-26). The costs are passed on to consumers in the form of higher meat prices. The seasonal shortage of rail cars is due to a slow north-south rotation of cars by the RAN. The rotation is slow because merchants who ship goods north in the cars are reluctant to unload them once they arrive in Upper Volta, due to a lack of warehouse space.

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[1] Viewed another way, the 9 percent carcass weight loss is the equivalent of losing one out of every eleven animals shipped.

[2] Regie de Chemin de Fer Abidjan-Niger, the railroad linking Ouagadougou and Abidjan.

TABLE 14

ESTIMATED MORTALITY RATES OF CATTLE DURING RAIL SHIPMENT TO ABIDJAN: 1976-77
(PERCENT)

Point of Departure	Distance from Abidjan (km.)	Average Trip Length (days)[a]	Number of Cars in Survey[b]				Estimated Mortality Rate (Percent)			
			H12	H13	J14	Total	H12	H13	J14	Overall
Upper Volta										
Ouagadougou	1,155	3.5	194	26	137	357	1.3	1.9	1.8	1.6
Koudougou	1,062	3.4	51	1	8	60	1.3	0	2.5	1.4
Bobo-Dioulasso	806	3.1	133	33	21	187	0.9	1.5	2.3	1.2
Ivory Coast										
Ouangolodougou	616	1.7	30	1	1	32	0	0	0	0
Ferkéssédougou	560	1.6	158	8	18	184	0.1	0	0.8	0.1
Tafiré	498	1.6	13	2	0	15	0	0	0	0
Bouaké	326	1.8	14	1	1	16	0	0	0	0

[a] Results from survey. See 27, pp. 239-41 for details.

[b] H12, H13, and J14 refer to different types of cattle cars.

Conclusions

The data collected during the study indicate that cattle merchants currently rely heavily on trekking because trekking is the cheapest way of moving cattle within the savanna zones. Not only are the cash costs of trekking low; the indirect costs, in terms of mortalities and weight loss en route, also appear low during most of the year. Although it involves a slower rate of capital rotation than trucking or rail transport, trekking remains the most profitable way of moving cattle to market in much of Ivory Coast.

Cattle merchants, however, do not rely exclusively on this method of transport. Merchants are quite sensitive to relative transport costs, and have adopted modern means of transport when it has been profitable to do so. For example, virtually all cattle shipped from Upper Volta to Abidjan travel by rail because the distance involved is great (over 1,100 km. between Ouagadougou and Abidjan) and because trekking in the southern half of Ivory Coast is difficult. Similarly, many merchants who export cattle from Mali to Bouaké trek their animals during the rainy season, but shift to a mixture of trekking and rail transport during the dry season, when the risk of mortalities and weight losses during trekking increase. This sensitivity on the part of merchants to relative transport costs suggest that as roads and rail transport improve and cattle prices rise, merchants will increasingly rely on trains and trucks to ship their cattle to market.

FACTORS AFFECTING THE LOCATION OF SLAUGHTER

In recent years, governments of the Sahelian countries and donor agencies have promoted the construction of modern abattoirs in the northern livestock-producing areas, with the goal of shipping refrigerated meat to the coastal areas. The Ivory Coast government has followed a similar policy, contracting for the construction of a refrigerated abattoir in Ferkéssédougou, which will ship meat south to Abidjan. Policy makers see two advantages in slaughtering in the north and shipping the meat south. First, the shrinkage and mortality losses associated with the shipment of live animals would be reduced or eliminated. Second, slaughtering in the north would increase value added in the north.

To date, however, it has remained more profitable to ship live animals south than to ship chilled meat, and as a result, the chilled meat trade has not developed as planners had hoped that it would. Table 15 illustrates the problem, comparing the profits that could have been earned in early 1977 shipping chilled beef to Abidjan from Ferkéssédougou, where the Ivorian government is constructing a new abattoir, with those that could be earned shipping cattle along the same route.[1] Table 15 shows that given the prices and costs prevailing in early 1977, a merchant could have earned nearly twice as much shipping cattle between Ferkéssédougou and Abidjan [illegible] e could have earned slaughtering the animals in Ferkéssédougou and shi[illegible] the carcasses south. A similar situation prevailed for shipments of cattle and chilled meat to Abidjan from Bamako and Ouagadougou (27, Chapter 7).

One reason it has remained more profitable to export cattle than meat is the high cost of shipping chilled meat in West Africa. Frequent breakdowns of refrigeration equipment (especially of the poorly maintained refrigerated rail cars used to ship meat between Upper Volta and Abidjan) lead to deterioration of the meat, adding significantly to transport costs.

Transport costs, however, are not the only determinants of the relative profitability of cattle and meat exports. The amount of money that can be earned selling the fifth quarter in the north compared to selling it in the south also plays a crucial role. A model presented in the Appendix

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[1] In Table 15 and in the subsequent analysis in this section it is assumed that the fifth quarters (i.e., all salable offals) of animals slaughtered in the north are sold in the north and are not shipped south. Typically, without processing, offals tend to spoil quickly. Mittendorf (9, p. 16) reports that even when offals are frozen for shipment south, they lose from 25 to 50 percent of their retail value because of West African consumers' preference for fresh offals.

TABLE 15

COMPARISON OF THE PROFITABILITY OF SHIPPING MEAT AND CATTLE FROM FERKESSEDOUGOU TO ABIDJAN (IN CFAF)

Expenses/Receipts	Cost per Animal
Meat Shipment	
Expenses	
Purchase of Animal having 160 kg carcass weight in Ferkéssédougou @ 337 CFAF per kg carcass weight	53,920
Slaughter Expenses	
Slaughter tax, veterinary inspection, and cold room fees	2,500
Amortization of burcher's license and union fees	347
Preparation of the carcass for shipment 2 CFAF per kg	320
Loss through seizures (0.5 percent)	282
Sale of fifth quarter in Ferkéssédougou	-5,000
Total Slaughter Cost Minus Value of Offals Sold in Ferkéssédougou	-1,551
Refrigerated Rail Shipment: 23,155 CFAF per ton	3,705
(Refrigerated Truck Shipment: 30 CFAF per kg)	(4,800)
Unloading of Train Car or Truck: 500 CFAF per car of 8 tons (50 carcasses)	10
Veterinary Inspection Tax in Abidjan: 10 CFAF per kg	1,600
Total Expenses: Train	57,684
Total Expenses: Truck	58,779
Weight Loss in Transit: 1.5 percent	2.4 kg
Weight of Meat Arrived in Abidjan	157.6 kg
Sale Price per kg in Abidjan	400 CFAF
Gross Receipts	63,040
Profit per Animal	
Rail Transport	5,356
Truck Transport	4,261

See following page for continuation of Table 15

TABLE 15 - CONTINUED

Expenses/Receipts	Cost per Animal
Live Animal Shipment (25 head)	
Expenses	
Purchase of Animal of 160 kg carcass weight in Ferkéssédougou @ 337 CFAF per kg carcass weight	53,920
Salary of Drover 5,000 CFAF for 25 head	200
Food for Drover: 1,000 CFAF	40
Return Passage for Drover	--
Round Trip for Owner: 4,000 CFAF	160
Food for Owner in Abidjan: 7 days @ 200 CFAF = 1,400 CFAF	56
Health Certificate: 3,500 CFAF	140
Loss of Animals	--
Forced Sales: 1.5 percent of 25 animals @ 20,000 CFAF loss per animal = 7,500 CFAF	300
Amortization of Cattle Merchants License	242
Rail Transport	
1 H12 car @ 62,558 CFAF	2,502
Straw: 500 CFAF	20
Loading/Unloading: 1,000 CFAF	40
Other: 1,000 CFAF	40
Abidjan Cattle Market Tax	500
Gift to Landlord	0-100
Total Expenses	58,160 to 58,260
Loss of Carcass Weight (2 percent)[1]	3.2 kg
Carcass Weight of Animal in Abidjan	156.8 kg
Sale Price of the Animal per kg Carcassweight in Abidjan	422 CFAF
Gross Receipts	67,738
Profit per Animal	9,458 to 9,558

SOURCE: Staatz, John M., The Economics of Cattle and Meat Marketing in Ivory Coast (Ann Arbor: Center for Research on Economic Development: 1979), pp. 256-57.

shows that under existing conditions, three factors determine whether it is more profitable to export live animals or meat from the north: the price of meat in the south, the price of the fifth quarter in the north, and relative transport costs and shrinkage for cattle and meat. Contrary to a popularly held view, with given transport costs, if the prices of meat and offals in the south rise relative to prices in the north it becomes relatively less, not more, profitable to ship meat than live animals.[1] By slaughtering in the north a merchant forgoes the income he could have earned by selling the fifth quarter in the south, where its price is higher. An increase in meat prices in the south relative to the north will increase the profitability of exporting meat as opposed to live animals only if the price of offals in the south falls relative to the price of meat in the south, a situation unlikely to occur in Abidjan in the next five to ten years. Furthermore, expansion of slaughter in the north in order to increase meat exports would tend to be self-braking. Expanded slaughter in the north would increase the supply of offals in the north, and with no increase in the demand for offals in the north, their price would fall. This would increase the relative profitability of sending the offals south (in the form of a live animal), where their price was higher, rather than slaughtering in the north and selling the offals locally.

The model shows that under conditions likely to prevail during the next five to ten years, the only way in which it could become more profitable to export meat as opposed to live animals would be for the costs of slaughtering in the north and transporting carcasses south to fall relative to the cost of transporting live animals south, or for the price of the fifth quarter in the north to increase relative to the price of meat in the south. Furthermore, if only relative transport costs changed, expansion of slaughter in the north would be self-braking because of a fall in the relative price of offals in the north. Therefore, if exporting meat from the north is to become and remain more profitable than exporting live animals, not only must slaughter costs in the north and the cost of transporting meat fall relative to the cost of transporting live animals, but the price of the fifth quarter in the north must also rise relative to the price of the fifth quarter in the south. One way to increase the demand for the fifth quarter in the north (and hence its price) would be to build processing facilities for offals in the north. Processing would allow northerners to export the fifth quarter to areas where the demand for it is high, rather than being forced to sell it in the north, where the demand for it is limited. This, in turn, would increase the relative profitability of exporting meat as opposed to live animals.

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[1] The absolute profitability of exporting meat increases as the price of meat and offals in the south increases relative to prices in the north, but the relative profitability of meat as opposed to live animal exports falls.

CATTLE AND MEAT PRICES: THEIR IMPLICATIONS FOR NORTHERN FATTENING PROJECTS

The profitability of most livestock development projects ultimately depends in large part on the retail demand for different types of meat. The nature of this demand is reflected in the prices of different types of cattle and of different cuts of meat. This section uses data on cattle and beef prices and information gathered during interviews with meat consumers to draw inferences about the nature of the demand for beef in Ivory Coast and how it is likely to change in the near future.

Types of Markets for Beef in Ivory Coast and Projected Production of Different Grades of Beef

Ivory Coast has two distinct markets for beef: the class 1 market, made up of supermarkets and European-style butcher shops; and the class 2 market, made up of butchers who sell meat in open market stalls. The class 1 market, which caters to the urban elite (expatriates and high-income Africans), handles slightly over 1,800 tons of beef per year, about 4 percent of the total beef consumed in Ivory Coast. Thus, the market for high quality beef in Ivory Coast is small, both in absolute and relative terms.

Projected production of high-quality beef in central West Africa, however, is high. SODEPRA[1] is currently operating a feedlot at Ferkéssédougou, and the National Plan projected output from this feedlot would total 16,000 head by 1980, the equivalent of 1,600 tons of fattened rear quarters.[2] The National Plan calls for a second feedlot to be built in 1980, with a capacity of 20,000 head per year, or 2,000 tons of fattened rear quarters. Mali plans to export 19,000 head of fattened cattle per year to Ivory Coast by 1980 (20), the equivalent of 1,900 tons of fattened rear quarters. Three feedlots have been constructed near Banfora in Upper Volta, with a total capacity of over 6,000 head per year (600 tons of fattened rear quarters) (7). The financial success of almost all these projects depends on the ability of the feedlot operators to sell the fattened animals (or the meat from these animals) at a premium on the Ivorian market. The projected production from these feedlots, however, far exceeds the demand for high-quality beef in Ivory Coast. The production of high quality rear quarters is projected at about 6,000 tons in 1980, while the total demand for high quality beef in Ivory Coast is unlikely to exceed 2,000 tons.

The question arises whether alternative markets can be found for this beef. While some markets may exist in other coastal states (particularly Nigeria), many of these states are setting up their own feedlots. It is therefore likely that the bulk of this high-quality beef, if it is produced, will have to be sold on the class 2 market.

Demand for Fattened Beef in the Class 2 Market

Data on cattle and retail beef prices collected during the study suggest some preference in the class 2 market for fattier, more tender meat. Cattle prices can be used in two ways to draw inferences about the retail demand for tender meat. First, the prices of heavy animals can be compared with those of lighter animals in order to see whether a premium was paid for the larger, generally better-fed animals. Second, the prices of animals of different breeds and sexes can be compared to see if prices are higher for those breeds and sexes reputed to yield fattier meat.

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[1] Societé pour le Développement des Productions Animales, the Ivorian government agency in charge of promoting domestic livestock production.

[2] In 1978, however, the feedlot's manager said that production in 1980 would probably total only about 10,000 head (26).

Cattle Prices.-- Data from Bouaké indicate that once the value of the fifth quarter was taken into account, the price per kg carcass weight of zebu males having carcasses 190 kg and heavier was about 1.5 percent higher than the price per kg of males with carcasses of between 130-159 kg.[1] Although such a comparison is hampered by the fact that the weight differences among animals were sometimes due to differences in the frames of the animals, not their degree of finish, it does suggest that class 2 butchers in Bouaké paid a slight premium for fattier, more tender meat.

The preference of consumers, and hence butchers, for fattier meat can be seen more clearly by comparing the prices paid for different breeds and sexes of cattle. Both class 1 and class 2 butchers in Abidjan and Bouaké reported that zebus usually yielded fattier meat than did taurins, and that consumers preferred this fattier meat. Similarly, butchers reported that steers usually yielded fattier meat than either bulls or cows. Table 16 presents average monthly prices in Bouaké of zebu males, zebu-taurin crossbreeds, and taurins during the study period. The table shows that in ten of the thirteen months under consideration the price per kg carcass weight of zebus was above that of taurins and that in nine of the thirteen months the price of zebus was above that of zebu-taurin crossbreeds. For the period as a whole, the price per kg carcass weight of zebu males averaged 369 CFA F, compared with 363 CFA F for zebu-taurin crossbreeds and 351 CFA F for taurins.[2] The higher price per kg carcass weight of zebus reflected the aforementioned preference of consumers, and hence butchers, for the fattier meat from zebus.[1] As would be expected, the price of per kg of zebu-taurin crossbreeds was intermediate between that of zebus and that of taurins.

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[1] See 27, p. 336-37 for details.

[2] T-tests indicated that differences were statistically significant (27, pp, 332-37).

The prices for taurins and zebu-taurin crossbreeds shown in Table 16 are not broken down by sex or weight of the animal. It is therefore conceivable that the price differences observed in Table 16 resulted from factors other than breed. An economic model of the demand for slaughter cattle in Bouaké was therefore constructed in order to test for significant differences among the prices of different types of cattle (27, pp.343-53). The model allows comparison of average prices by breed and sex, while holding weight and month of sale constant. Table 17 presents the relative prices per kg. of different types of cattle as estimated by the model.

Table 17 confirms that the price per kg carcass weight of zebus was higher than that of other breeds. It also shows that, as expected, the price per kg of steers was higher than the price per kg of either bulls and cows. This pattern of relative prices strongly suggests that consumers in the class 2 market preferred fattier, more tender meat; as mentioned above, zebus generally yielded meat was a higher fat content than did taurins, and steers yielded fattier meat than did either cows or bulls.

Retail Meat Prices.-- Retail meat prices also suggest that consumers who bought beef on the class 2 market preferred some fat in their diet. Beef is sold on the class 2 market both by weight and in small unweighed piles called *tas*, which are composed of skeletal meat, offals, fat, and bone. When prices of *tas* are regressed against the weight of meat, bones, offals, and fat in the *tas*, the coefficients in the resulting equation

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[1] This preference was reflected in the retail market by the ease with which a butcher could sell his meat. Butchers reported that when they sold meat from taurins they sometimes had trouble selling all their meat during the morning. They were thus required to either put in longer hours at the market to sell all their meat or sell the meat the next day (or in the evening) at a discount.

TABLE 16

AVERAGE MONTHLY CATTLE PRICES IN BOUAKE: JULY 1976-JULY 1977
(CFAF per kg carcass weight)

Month/Year	Zebu Males (130-159 kg. carcass weights)	Zebu-Taurin Crossbreeds[a]	Taurins[b]
1976			
July	344	360	302
(s.d.)[c]	(28)	(28)	
N[d]	23	5	1
August	359	330	335
(s.d.)	(34)	(27)	(27)
N	17	6	6
September	344	321	342
(s.d.)	(37)	(22)	(21)
N	25	2	10
October	343	356	334
(s.d.)	(28)	(58)	(30)
N	32	15	10
November	340	336	329
(s.d.)	(31)	(28)	(34)
N	45	20	4
December	395	383	360
(s.d.)	(45)	(29)	(40)
N	46	33	4
1977			
January	366	364	326
(s.d.)	(29)	(37)	
N	42	40	1
February	382	370	380
(s.d.)	(27)	(32)	(39)
N	58	29	10
March	377	381	324
(s.d.)	(28)	(30)	(28)
N	34	22	2
April	382	389	391
(s.d.)	(33)	(34)	(44)
N	41	32	11

Table 16 continued on next page.

TABLE 16 - CONTINUED

Month/Year	Zebu Males (130-159 kg. carcass weights)	Zebu-Taurin Crossbreeds	Taurins
May	381	376	392
(s.d.)	(25)	(30)	(21)
N	34	28	2
June	406	382	372
(s.d.)	(35)	(31)	(26)
N	21	18	16
July	376	371	382
(s.d.)	(25)	(33)	(27)
N	8	5	4
Average[e]	369	363	351

[a] The average carcass weight of the 255 zebu-taurin crossbreeds in the sample was 144 kg.

[b] The average carcass weight of the 81 taurins in the sample was 126 kg.

[c] Standard deviation.

[d] Number of observations.

[e] Unweighted average of monthly prices.

TABLE 17

RELATIVE PRICES PER KG. OF DIFFERENT TYPES OF CATTLE
SOLD IN BOUAKE, 1976-77
(percent of price per kg of zebu steers)[a]

Breed	Steers	Bulls	Females
Zebus	100.0	96.8	98.9
N'damas	95.9	92.7	94.8
Baoulés	98.3	95.1	97.2
Zebu-Taurin Crossbreeds	99.0	95.8	97.9

[a] See 27, pp.352-53 for details of how these prices were calculated.

represent the implicit prices per kg of each of those constituents. Comparing these implicit prices yields insight into how much consumers value each of these items in their diets.

Analysis of data from Bouaké indicate that for large tas the implicit prices per kg in 1976-77 were the following: skeletal meat -- 438 CFA F; offals -- 371 CFA F; fat -- 286 CFA F; and bone -- 290 CFA F.[1] The fact that the implicit price of fat in the tas was nearly 300 CFA F per kg strongly suggests that Ivorian consumers desire some fat in their diet.

Factors Limiting the Effective Demand for Fattened Beef

Although consumers in the class 2 market prefer fattier, more tender meat, the degree to which this preference translates into higher prices for well-fed animals is limited by three factors: consumers' dislike for meat that is "too fat," traditional eating habits, and low consumer incomes.

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[1] See 27, pp.441-44 for details. Because of strong intercorrelation (r = .85) between the amount of meat and the amount of bone in the tas, the implicit price of bone was probably overestimated and that of meat underestimated.

Ivorian consumers apparently like some fat in meat, but they complain if beef is "too fat," i.e., if the carcass is covered by a thick layer of fat. Consumers interviewed in Bouaké often cited this as a reason for their not buying imported frozen beef, even though the frozen meat was cheaper than locally slaughtered beef. Traditional eating habits also limit the effective demand for tender meat. Traditionally, meat is consumed in West Africa as part of a sauce that is boiled for several hours. Given this method of preparation, there is little reason to pay a premium for especially tender meat. The effective demand in the class 2 market for tender meat is further limited by the low income of most consumers. Most consumers who buy meat on the class 2 market have little income left to pay a premium for tender meat after meeting their basic needs. Demand for tender meat can be expected to grow, however, as incomes increase. With higher incomes and greater employment possibilities outside the home for women, the opportunity cost of the long time spent preparing meals by traditional methods will increase. Consumers will therefore shift to more rapid means of preparing meat, such as grilling, for which the tenderness of the meat is an important consideration.

What consumers in the class 2 market currently are looking for, then, is meat from a well-fleshed, but not a finished, animal. Butchers who sell on the class 2 market therefore pay slightly more (up to about 7 percent more per kg carcass weight) for animals yielding fattier meat than for lean animals. Effective demand for well-fleshed animals in the class 2 market is probably not high enough, however, to absorb at a premium price all the fattened cattle scheduled to be produced from northern feedlots in the next few years.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The major conclusions and policy recommendations of the study fall under seven headings: 1) the changing Ivorian market for beef; 2) the organization of cattle and meat marketing; 3) market infrastructure needs; 4) problems of transporting cattle; 5) the location of slaughter;

6) the nature of demand for beef in Ivory Coast and the implications of this demand for northern cattle fattening projects; and 7) general recommendations for marketing policy in the future.

The Changing Ivorian Market for Beef

A crucial question facing Ivory Coast and its northern neighbors is the following: during the next few years, how dependent will Ivory Coast be on cattle imports from the Sahelian countries? The question is especially important to the Sahelian countries in light of three recent changes that have reduced the importance of imported cattle as a source of protein in the Ivorian diet:

1) Ivorian consumers have increasingly substituted fish for beef in their diets as the price of beef has risen relative to fish;

2) Ivory Coast's imports of cattle from the Sahelian countries have fallen, and since 1975 they have been replaced in part by imports of frozen beef from non-West African suppliers; and

3) the Ivorian government has launched a series of projects aimed at increasing domestic livestock production (espeically poultry and pork production) in order to reduce Ivory Coast's reliance on imports.

In spite of the decreased importance of livestock imports in recent years, Ivory Coast will probably continue to rely on them for a large part of its animal protein supply during the next five years. Prices on the world beef market were usually low during 1975 and 1976, when Ivory Coast first began importing large quantities of frozen beef, and are likely to rise substantially at least through 1980 (27, pp. 447-48). Therefore, even though the Ivorian market for beef is now integrated with the world market, increasing prices for beef on the world market may discourage Ivory Coast from importing beef from non-West African suppliers. The price of fish imported into Ivory Coast is also increasing, and importers contacted in Ivory Coast expected it to continue to increase during the next few years.[1] Therefore, it is unlikely that consumers will continue to substitute fish for beef in their diets to the degree to which they did between 1970 and 1975. Domestic Ivorian production of poultry and pork has increased in recent years, as has consumption of these substitutes for beef. Per capita consumption of poultry and pork, however, remains much lower than beef consumption, and data on consumer preferences (4) suggest that it would take a large change in relative prices to effect widespread substitution of pork and poultry for beef in the diet. Such changes seem unlikely in the next five to ten years.

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[1] Imported frozen fish, which makes up the bulk of Ivory Coast's fish supply, increased in price about 10 percent between 1977 and 1978 (1).

Ivory Coast's continued reliance on the Sahelian countries for the bulk of its beef supply has important implications, both for the Sahelian countries and for Ivory Coast itself. The Sahelian countries should realize that Ivory Coast will continue to be an important market for their livestock exports, but not on the same terms as prior to 1975. Ivory Coast has already met many of the fixed costs of importing non-West African frozen meat (e.g., it has contacted exporters, constructed cold storage facilities, and introduced consumers to the product); therefore, it will be relatively easy for Ivory Coast to enter the world market when the world price of beef is below the West African price. It is therefore in the Sahelian countries' interest to facilitate the flow of cattle southward to Ivory Coast (e.g., by improving livestock transport and simplifying export procedures) in order to improve the competitive position of the Sahelain countries vis-à-vis non-West African meat exporters. Ivory Coast will probably remain an important export market for the Sahelian countries, particularly for Mali and Upper Volta, but it is not a market that can be taken for granted.

The world price of beef will probably rise markedly in the next five years; therefore, Ivory Coast's continued reliance on the world market for a large part of its beef supply may prove very costly. It is therefore also in Ivory Coast's interest to facilitate the flow of livestock south from the Sahelian countries, e.g., through improved trekking routes. By making it easier and cheaper for northern livestock merchants to ship their animals south, Ivory Coast can help assure that at least part of the increase in demand for animal protein that will result from the country's population growth, urbanization, and growth in per capita income will translate into an increase in meat consumption, not just an increase in prices.

The Organization of Cattle and Meat Marketing

The research showed that the traditional cattle and meat marketing system is fairly efficient, given the physical infrastructure constraints under which it operates. Market concentration is typically low to moderate, collusion to restrict sales in order to raise prices seems rare, and the profit margins of cattle merchants and butchers do not appear exorbitant. In short, the marketing system for cattle and beef seems to be fairly competitive.

One reason that the market is fairly competitive and net margins are modest is the relative ease of entry into the cattle and meat trades. Since it is fairly easy to enter the trade, there are many buyers and sellers in major markets, and competition among them holds down profit margins. Most plans put forward by government officials for reorganization of the cattle and meat trades involve restricting the number of people involved in the trade, either through strict licensing or by replacing certain market agents by state agencies. While officials may feel that strict licensing requirements would allow the government a higher degree of control over cattle and meat marketing, officials should also realize that by restricting access to the trade, licensing reduces competition and usually leads to higher meat prices. Indeed, the main effect of limiting the number of butchers' licenses issued in Bouaké and Abidjan has been to create a black market in licenses that has made it difficult and expensive for young butchers to enter the trade.

The traditional marketing system is labor-intensive, using little capital other than the cattle sold. Most plans for market reorganization and abattoir improvement involve replacing some of the labor involved in marketing with imported capital equipment. Such plans also would usually disrupt the indigenous training system for butchers and traders. When planning marketing projects, officials should carefully consider the employment effects of these projects. They should also realize that it may not always be appropriate to adopt European or North American models of slaughter and livestock and meat marketing in Ivory Coast because the economic parameters upon which these models are based (e.g., the relative prices of capital and labor) are different in Ivory Coast than in Europe or North America.

Finally, the study has shown that even though butchers in Abidjan and Bouaké ignore official price controls, butchers' net margins are quite low. This implies that the butchers' trade is competitive enough to prevent price-gouging by butchers even without price controls. Removing retail price controls on beef in Abidjan and Bouaké therefore probably would not lead to a rapid increase in prices.

Market Infrastructure Needs

The research showed that much of the market infrastructure provided by recent livestock marketing projects does not contribute to increased market efficiency and usually remains unused by butchers and cattle traders. There are areas, however, where new market infrastructure could contribute substantially to improved cattle and meat marketing. The Abidjan abattoir, for example, is in very poor condition, and rebuilding it would be justified on grounds of both public health and the safety of those who work in it. The lack of grazing space around the Abidjan abattoir and cattle market represents another critical infrastructure contraint to cattle marketing in Ivory Coast. The lack of grazing prevents butchers and cattle merchants from holding a buffer stock of animals as a hedge against supply fluctuations. The lack of a buffer stock combines with irregular arrivals of cattle by rail to result in highly fluctuating supplies in Abidjan and hence highly fluctuating cattle prices. Since Abidjan absorbs about 40 percent of all beef consumed in Ivory Coast (27, p. 58), price instability in Abidjan represents a major problem for cattle merchants and butchers in Ivory Coast. Until the cattle market-abattoir complex in Abidjan is moved to an area with adequate grazing or until means are found to provide forage to the cattle at the present location economically, traders will continue to demand a high risk premium to ship cattle to Abidjan and the high rate of default on debts by Abidjan butchers will likely continue.

In providing new market infrastructure, planners should keep three principles in mind. First, the technology adopted should be in line with local, not overseas, costs of capital and labor. In developed countries capital is relatively cheap and labor is relatively expensive, while in West Africa just the reverse is true. By adopting infrastructure (e.g., abattoirs) designed for price conditions in developed countries, planners in West Africa risk replacing cheap local labor with expensive imported capital. Planners should therefore try, wherever possible, to adapt European or North American infrastructure plans to local price conditions. The second point is that the equipment adopted should be simple and easy to repair. All equipment breaks down eventually, and in general, the more complicated the equipment, the more likely it is to break down, especially given heavy use by relatively untrained personnel. Equipment is most likely to be repaired quickly if parts are available locally at low cost. If expensive spare parts have to be imported, the equipment may be out of service for a long time, leading to serious bottlenecks in marketing or slaughtering. The third point is that it often may be much cheaper to use locally produced, rather than imported materials for infrastructure construction. For example, it may prove cheaper to construct the enclosures in cattle markets with locally produced cement bricks (as was done in Abidjan and Bouaké) than with imported steel pipe (as was done in Man). Use of local materials has the added benefit of generating local employment in the manufacture of these items.

Problems of Cattle Transport

The research showed that trekking is usually the least expensive way of moving cattle within the Sudanese and Guinea savanna regions and that trucking is the most expensive. Trucking is expensive because truck rental rates per animal are high (due to the low weight-to-volume ratio of cattle as compared with other cargoes) and because truckers and merchants are forced to pay substantial unofficial costs *en route* (e.g., bribes). Therefore, if Ivorian officials want to hold down meat prices in the cities, it would be inadvisable at this time to force merchants to truck their cattle to market. Merchants, who are quite sensitive to relative transport costs, will shift to long-distance trucking when it becomes profitable for them to do so. The widespread use of trucking within the forest zone indicates that merchants are not opposed to trucking per se; they are only opposed to trucking when more economical means of transport are available. As roads improve and cattle prices rise, the relative profitability of long-distance trucking will increase, leading merchants to ship their cattle by truck.

For the next several years, however, trekking will probably remain the most profitable way of transporting cattle within the savanna zones. Trekking costs could be reduced by the establishment within Ivory Coast of clearly marked cattle trails along which cattle would have right-of-way. Such trails, like those that exist in Upper Volta, would facilitate the flow of cattle southward, reduce the possibility of imported cattle spreading disease to domestic livestock (by restricting imported cattle-specified routes), and lower the incidence of crop damage by trade herds. Trekking losses could be reduced by constructing a few dipping tanks along these trade routes (to reduce weight losses and mortalities resulting from tick-borne diseases) and by providing dry-season watering facilities.

The research showed that the cost of crop damage caused by trade herds is very low when expressed in terms of cost per animal trekked. The problem is that the cost is borne by only a few people, the farmers whose fields are damaged. Although the creation of clearly marked cattle trails in Ivory Coast would reduce the incidence of crop damage, it probably would not eliminate it. One way to handle the problem of compensating farmers for crop damage would be to levy a small tax, e.g., 25 to 30 CFA F per head, on all cattle trekked within the country.[1] The proceeds of this tax would go into a fund administered by the Ministry of Agriculture to compensate farmers whose crops had been damaged by trade herds. Even if the cost of administering the fund were substantial, this solution would be much cheaper for the country than forcing merchants to truck their cattle, the cost of which would be reflected in higher meat prices and seasonal transportation bottlenecks.

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[1] This tax could be collected by veterinary agents when they issue a health certificate (*laissez-passer sanitaire*) to the herd.

Rail transport will continue to be an important means of moving cattle to market, particularly to Abidjan. The cost of shipping cattle by rail, however, is high, especially in terms of the shrinkage and mortality losses en route and the costs of waiting several days in the north for train cars to become available. The RAN should act to reduce the time cattle spend in transit by assuring that trains carrying livestock are given priority over trains carrying other merchandise. The RAN should also consider creating express trains for livestock, either separately or as part of passenger trains. Typically, when cattle are shipped by rail, during much of the time the animals are in the cattle cars, the train is not moving. Three delays are especially important: after the cattle have been loaded in Upper Volta but before the train leaves the station (this delay averages about eight hours in Ouagadougou); at the Voltaic-Ivorian border; and in Abidjan at the Treichville train station, before the cattle are shipped the eight kilometers to the cattle market at Port Bouët (this delay often lasts ten to twelve hours). These delays add significantly to the mortality and weight losses of the cattle during shipment; therefore, the RAN should work with Voltaic and Ivorian customs officials and Abidjan market officials to reduce these delays to a minimum. For example, if the unloading facilities at the Abidjan market were improved and merchants were allowed to pay their RAN bills in advance or as soon as the train arrived in Abidjan, cattle could be unloaded in Abidjan at night, often cutting ten to twelve hours off the time the animals spend in the cattle cars.

In the long run, the RAN should consider replacing its poorly-ventilated cars with open-slatted cattle cars, which would further reduce shrinkage and mortalities en route. The RAN should also study the possibility of feeding and watering cattle en route, either in the cars or at rest stops where the cattle would be unloaded.

The seasonal shortage of rail cars that forces merchants to wait a week or more in the north for cars could be lessened by a change in the RAN's rate structure. If the RAN were to sharply increase the daily rental rate charged for unloaded cars sitting on sidings, merchants who ship goods north would be induced to unload the cars quickly, leading to a more rapid rotation of these cars. Data presented elsewhere (27, pp. 190-96) indicate that during the 1976-77 the rate of rotation of cars used to ship cattle south was very low, and that a faster rotation of cars could go a long way to reduce the seasonal transportation bottleneck.

The Location of Slaughter

The research showed that given 1977 prices, it was more profitable to ship live animals south for slaughter than to slaughter them in the north and ship their carcasses south. Furthermore, unless large changes occur both in relative transport costs for livestock and meat and in prices of meat and offals in the north and the south, it is likely to remain more profitable to ship live animals south than to ship meat. Planners therefore should not expect much expansion in the chilled meat trade between the north and the south unless they take actions both to reduce transport costs for meat relative to livestock and to change the prices of meat and offals in the north relative to the south.

The model presented in the Appendix shows that the value received for the fifth quarter plays a crucial role in determining the relative profitability of meat versus live animal exports. Unprocessed offals cannot be shipped easily by refrigerated transport, and if there is little demand for them at the point of slaughter, it usually is more profitable to ship the entire animal south, where the price of the fifth quarter is higher, than to slaughter in the north and ship only the carcass south. If planners want to expand the chilled meat trade between the north and south they should therefore take measures that will increase the value of the fifth quarter in the north, e.g., by establishing processing facilities for offals that will allow offals to be exported to areas of high demand. If planners only worry about the problem of "disposing" of the fifth quarter in the north, and not of generating effective demand for offals in order to boost the price of the fifth quarter in the north, it will probably remain more profitable to export live animals to the south than to export meat.

The Nature of Demand for Beef in Ivory Coast: Implications for Fattening Projects

Data collected during the study indicate that production of high quality beef in central West Africa is likely to far exceed demand for this beef by 1980. The profitability of many of the feedlots being established in the area is premised on their ability to sell their animals for a premium on the Ivorian market. The projected supply and demand figures suggest, however, that by 1980 there may be such a surplus of fattened beef on the market that class 1 retailers will not have to pay a premium for this beef. The data show that consumers in the class 2 market prefer fattier, more tender meat, and that the class 2 market could absorb some of the animals from these feedlots. The degree to which the preference of consumers in the class 2 market for fattier, more tender meat will translate into higher prices for these animals, however, will be limited by consumers' dislike of meat that is "too fat," by traditional eating habits, and by low consumer incomes.

The preceding paragraph suggests that some of the fattening projects in the north should be directed away from their current four- to six-month fattening period towards shorter fattening periods aimed at producing well-fleshed, but not fat animals. There is some room for replacing currently imported high quality beef with locally produced beef, but the market for high quality beef is small. The bulk of the beef sold in Ivory Coast will continue to go to the class 2 market, where the demand for higher quality meat is limited. This market could absorb more well-fed animals from short-term (one to three months) fattening schemes, but in planning such programs two points should be kept in mind. First, the projects should be based on a low-cost technology because the class 2 market offers only small premiums for fattened animals. Most of the profit in such projects will have to be made on the weight gain of the animal, not on a premium price paid for higher quality meat. Second, the growth of demand for higher quality meat in class 2 market will be contingent on the growth of per capita incomes in Ivory Coast. Demand for higher quality beef is therefore likely to grow only at a modest pace, and planners should be careful not to expand fattening projects so fast that the market is flooded with more well-fed cattle than it can absorb at prices that make the fattening projects profitable.

General Considerations to Guide Marketing Policy

An efficient cattle and meat marketing system is one that transforms cattle into meat and distributes the cattle and meat over time and among regions while minimizing the gross marketing margin. By minimizing the cost of performing the tasks of distribution, storage, and transformation, an efficient marketing system benefits both producers and consumers. Producers receive higher prices for their animals and consumers pay lower prices and receive larger quantities of meat than they would with an inefficient marketing system (29, pp. 120-24). Improving market efficiency therefore contributes directly to the stated goal of development policy in Ivory Coast, the improvement of the welfare of the individual.

The problem facing planners and donor agencies in Ivory Coast (and in all of West Africa) is how to reduce the gross marketing margins for cattle and meat in the least costly manner, given the tasks of distribution, storage, and transformation that the marketing system must perform. Two types of solutions have been proposed. The first, typified by the CEBV accords (5), calls for large-scale restructuring of the traditional marketing system,in the hope of assuring more government control over the market. Ghana has gone further than any other country in restructuring the trade, replacing the traditional marketing system with a state monopoly. The other type of solution involves working to relieve the transportation and infrastructure constraints in the current marketing system, in the hope that once these constraints are lessened, competition within the traditional marketing system will drive down gross margins.

The results of this study strongly suggest that the second approach is much more likely to succeed, and in the long run would be much cheaper than trying to totally restructure the marketing system. The research shows that while gross margins in the cattle and meat trades are high, net margins are modest. This implies that the marketing system is competitive and efficient given the infrastructure and transportation constraints under which it operates. The main reason why gross margins are high is because cattle merchants have high costs (e.g., in terms of mortality and shrinkage losses en route and high export taxes), not because merchants earn monopoly profits.

For the livestock and meat trade to expand in order to meet the needs of Ivory Coast's rapidly growing population, the transportation and infrastructure bottlenecks facing livestock marketing will have to be overcome, whether or not the trade is drastically reorganized. The real question facing Ivory Coast, then, is the following. Should Ivory Coast use its valuable resources (including its scarce veterinary and administrative personnel) to try to totally restructure livestock marketing while at the same time trying to relieve the transportation and infrastructure constraints, or should it concentrate its resources on relieving the transportation and infrastructure constraints, and let the traditional marketing system handle the tasks of distributing cattle and transforming cattle into meat?

Extensive reorganization of the marketing system would involve a very heavy cost in terms of the time of the government personnel who would be called upon to run the new system or enforce the new regulations. It would probably be a more efficient use of government resources for the government to work jointly with traditional cattle traders and butchers, most of whom are highly experienced and have a detailed knowledge of the cattle trade, to develop mutually acceptable improvements in the marketing system, rather than working against these marketing agents in an attempt to completely restructure the trade. Ivory Caost's only attempt to date to set up an alternative cattle marketing system, SODEPRA's Service de Commercialisation, has not been encouraging. Research shows that despite the expenses the state incurred in setting up and running the new marketing agency, the agency did not achieve its primary goal of offering northern Ivorian cattle producers prices that were significantly higher than those offered by traditional merchants (27, pp. 299-302). Certainly Ghana's recent experience with its state cattle marketing agency, the Ghana Meat Marketing

Board, should serve as a warning to planners about the difficulties of trying to replace the traditional marketing system with a state monopoly.

Working with the traditional marketing system does not mean the government will be without a role in cattle and meat marketing. The government has important roles to play in insuring the health of imported and domestically produced animals, safeguarding public health by insuring proper sanitation in the abattoirs, and improving the transportation and market infrastructure for cattle and meat. The government should not use its power, however, to restrict entry into the cattle and meat trades unless there is strong justification, e.g., in terms of maintaining public health. Restricting entry (usually through limiting the number of licenses issued) typically reduces competition, drives up marketing margins, and results in producers receiving lower prices for their animals and consumers paying higher prices for their meat.

A shift in government policy away from trying to totally restructure cattle marketing to an attempt to improve infrastructure and guarantee the competitiveness of the traditional marketing system implies a major change in the way in which livestock marketing projects are designed and implemented. In the past, donor organizations and government planners have typically designed marketing projects without consulting butchers, traders, or intermediaries about these market participants' perceptions of the major problems of cattle and meat marketing. Market participants were usually contacted (if at all) only after the project had been planned, in order to tell them what their new obligations would be as a result of the project. Seldom have planners tried to tap merchants' and butchers' knowledge of the trade when designing projects, nor have they often tried to design projects to respond to what the market participants feel are the major problems of cattle and meat marketing. As a result, many butchers and traders regard the government as an adversary, interested mainly in taxing them to finance projects they feel are unnecessary.

If livestock and meat marketing in Ivory Coast are to be improved efficiently and effectively, there needs to be more contact and two-way communication between market participants and the government officials and donor agencies in charge of planning market improvements. Market participants should be contacted early in the design stage of projects so that the projects can be modified to respond to what these marketing agents perceive as major problems in the trade. Certainly planners should not feel obligated to do everything the butchers and cattle traders suggest, but it would be equally unwise for planners to totally ignore these market participants when designing projects. Not only do butchers and traders have knowledge of the market that can be extremely useful in designing projects, but by involving the market participants in project design, planners can help assure that butchers and traders will cooperate in project implementation. It is also important that before planners advocate widespread changes in the marketing system, they understand why market participants behave as they do; often behavior that appears irrational at first glance is based firmly on economic principles.

APPENDIX

MEAT VERSUS LIVE ANIMAL SHIPMENTS[1]

This appendix presents a model that specifies the conditions under which it is more profitable to slaughter cattle in the north and ship their carcasses south than to ship the cattle south for slaughter. The model shows that the factors that determine whether it is more profitable to slaughter in the north than in the south are:

(a) shrinkage during shipments of live animals and meat;

(b) prices of meat and fifth quarter in the north and the south; and

(c) transfer costs for cattle and meat between the north and the south.

In the analysis it is assumed that the fifth quarters of animals slaughtered in the north are sold in the north and are not shipped south. Typically, slaughterhouses in the north do not export offals (other than hides) because without processing, offals tend to spoil quickly.

The profit from slaughtering an animal in the north and shipping the meat south to Abidjan is given by the equation:

$$M_M = DW_{LN}(1-L_M)P_{MA} + F_N P_{FN} - W_{LN}P_{LN} - C_M \qquad (1)$$

$$\begin{bmatrix}\text{Margin earned}\\ \text{shipping meat}\end{bmatrix} = \begin{bmatrix}\text{Receipts from}\\ \text{meat sold in}\\ \text{Abidjan}\end{bmatrix} + \begin{bmatrix}\text{Receipts from}\\ \text{fifth quarter}\\ \text{sold in north}\end{bmatrix} - \begin{bmatrix}\text{Purchase price}\\ \text{of animal}\end{bmatrix} - \begin{bmatrix}\text{Slaughter}\\ \text{and transfer}\\ \text{costs}\end{bmatrix}$$

where

M_M = net margin earned in shipping the meat to Abidjan;

D = dressing-out proportion of the animal (the carcass weight divided by the liveweight);

W_{LN} = liveweight of the animal in the north;

L_M = shrinkage of the refrigerated carcass during transit, expressed as a proportion of the original carcass weight;

P_{MA} = wholesale price per kg of meat in Abidjan;

F_N = weight of the fifth quarter in the north;

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[1] The author is grateful to Edgar Ariza-Nino for help in developing the model presented in this Appendix.

P_{FN} = average price per kg of the fifth quarter in the north;

P_{LN} = price per kg liveweight of the animal in the north; and

C_M = costs of slaughtering the animal in the north and shipping the meat to Abidjan.

Equation (1) states that the margin earned from shipping meat is equal to the value of the meat that arrives in Abidjan $[DW_{LN}\ (1-L_M)\ P_{MA}]$ plus the value of the fifth quarter sold in the north $[F_N\ P_{FN}]$ minus the purchase price of the animal in the north $[W_{LN}\ P_{LN}]$ and the costs incurred in slaughtering the animal and shipping the carcass to Abidjan $[C_M]$.

Similarly, the profit margin earned by shipping a live animal south to Abidjan is given by the equation:

$$M_L = DW_{LN}\ (1-L_L)\ P_{MA} + (1-L_L)\ F_N\ P_{FA} - W_{LN}\ P_{LN} - C_L \qquad (2)$$

$$\begin{bmatrix}\text{Margin earned}\\ \text{shipping}\\ \text{live animal}\end{bmatrix} = \begin{bmatrix}\text{Receipts from sale of}\\ \text{animal in Abidjan}\\ \end{bmatrix} - \begin{bmatrix}\text{Purchase price}\\ \text{of animal}\\ \end{bmatrix} - \begin{bmatrix}\text{Transfer}\\ \text{costs}\end{bmatrix}$$

where

M_L = net margin earned shipping the animal to Abidjan;

L_L = shrinkage of carcass and fifth quarter during shipment to Abidjan, expressed as a proportion of the original weights of the carcass and the fifth quarter [N.B. the percentage shrinkage is assumed to be the same for the carcass and the fifth quarter];

P_{FA} = average price per kg of the fifth quarter in Abidjan;

C_L = transfer cost of exporting the animal to Abidjan; and

D, W_{LN}, P_{MA}, F_N, and P_{LN} are as defined earlier.

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Equation 2 states that the margin earned exporting an animal from the north to Abidjan is equal to the amount received in Abidjan for the animal's carcass $[DW_{LN}\ (1-L_L)\ P_{MA}]$ and for its fifth quarter $[(1-L_L)\ F_N\ P_{FA}]$[1] minus the purchase price of the animal in the north $[W_{LN}\ P_{LN}]$ and the costs incurred in exporting the animal to Abidjan $[C_L]$.

It will be more profitable to slaughter in the north and ship the meat to Abidjan than to ship live animals to Abidjan when $M_M - M_L > 0$. Combining equations (1) and (2) it can be shown that:

$$M_M - M_L = DW_{LN}\ P_{MA}\ (L_L - L_M) - F_N[P_{FA}(1 - L_L) - P_{FN}] - (C_M - C_L) \qquad (3)$$

$$\begin{bmatrix}\text{Gain from}\\ \text{slaughter}\\ \text{in north}\end{bmatrix} = \begin{bmatrix}\text{Gain in meat value}\\ \text{from reduced}\\ \text{shrinkage}\end{bmatrix} - \begin{bmatrix}\text{Loss in receipts from}\\ \text{fifth quarter}\\ \ \end{bmatrix} - \begin{bmatrix}\text{Increase in}\\ \text{slaughter and}\\ \text{transport costs}\end{bmatrix}$$

Equation 3 states that the difference between the margins earned shipping meat and shipping live animals depends on three elements. The first, represented by the term $DW_{LN}\ P_{MA}\ (L_L - L_M)$, is the value gained due to the reduced amount of carcass shrinkage in meat shipments as compared to live animal shipments. The second element, represented by the term $F_N\ [P_{FA}\ (1-L_L) - P_{FN}]$, is the value lost by selling the fifth quarter in the north rather than in Abidjan, where its price is higher. The final element, $C_M - C_L$, is the difference between the per animal transfer costs of chilled carcasses and live animals.

If one assumes that the weight of the fifth quarter is some constant percentage, y, of liveweight (i.e., $F_N = yW_N$), one can state the conditions under which it will be more profitable to ship meat than to ship live animals. Substituting the new assumed value of F_N into equation (3) and letting X equal the ratio of the price of the fifth quarter in Abidjan to the price of meat in Abidjan (i.e., $X = \frac{P_{FA}}{P_{MA}}$), equation (3) can be expressed in slightly different terms:

$$M_M - M_L = W_{LN}\ P_{MA}[D(L_L - L_M) - yX(1 - L_L)] + yW_{LN}\ P_{FN} + C_L - C_M \qquad (3a)$$

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[1] In practice, the seller receives a single amount for the live animal that includes both the value of the carcass and the value of the fifth quarter.

Equation 3 will be greater than zero (i.e., it will be more profitable to ship meat than live animals) when:

$$W_{LN} P_{MA} (L_L - L_M) > yW_{LN}[X P_{MA}(1 - L_L) - P_{FN}] + C_M - C_L \qquad (4)$$

$$\begin{bmatrix}\text{Value of meat "saved"}\\ \text{due to reduced}\\ \text{shrinkage}\end{bmatrix} > \begin{bmatrix}\text{Receipts foregone by}\\ \text{selling fifth quarter in}\\ \text{north where its price is}\\ \text{lower}\end{bmatrix} + \begin{bmatrix}\text{Increase in}\\ \text{slaughter and}\\ \text{transport costs}\end{bmatrix}$$

Relationship (4) states that it will be more profitable to ship meat than live animals whenever the value of the meat "saved" due to the lower carcass shrinkage involved in meat shipments more than offsets the income foregone in selling the fifth quarter in the north rather than in the south, and the increase in slaughter and transport costs involved in shipping meat as opposed to live animals. Rearranging terms in relationship (4) and dividing through by W_{LN}, the liveweight, leads to the statement that it will be more profitable to ship meat than live animals ($M_M - M_L > 0$) when:

$$P_{FN} > \frac{P_{MA}\,[yX(1-L_L) - D(L_L - L_M)]}{y} + \frac{\bar{C}_M - \bar{C}_L}{y} \qquad (5)$$

where

$\bar{C}_M = \frac{C_M}{W_{LN}}$ = slaughter and transfer costs of meat, expressed in terms of cost per kg. original liveweight; and

$C_L = \frac{C_L}{W_{LN}}$ = per kg. transfer costs of live animals.[1]

Relationship 5 states that the relative profitability of exporting meat as opposed to live animals will increase only if one or a combination of the following things happen:

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[1] Since many of the costs of shipping of both cattle and meat (C_L and C_M) are proportional to the animals' weights (e.g., the number of animals or carcasses shipped per train car depends on their weights), $\bar{C}_L$ and $\bar{C}_M$ vary little with respect to the weight of the animal shipped.

1) the price of offals in Abidjan falls relative to the price of meat in Abidjan;
2) the average dressing percentage increases;
3) the amount of carcass shrinkage during meat shipments falls relative to the carcass shrinkage experienced in shipping live animals;
4) the price of the fifth quarter in the producing areas increases relative to the price of meat in Abidjan;
5) the costs of slaughtering in the north and transporting carcasses south fall relative to the costs of transporting cattle south.

From a policy perspective, the following factors in relationship (5) are of greatest importance because of their variability and their susceptibility to government policy management:

1) the price of meat in Abidjan, P_{MA};
2) the price of the fifth quarter in the north, P_{FA}; and
3) slaughter and transport costs for cattle and meat, $\bar{C}_L$ and $\bar{C}_M$.

The ratio of the price of offals in Abidjan to the price of meat in Abidjan, X, is also of critical importance, but as explained below, it is likely to remain fairly stable in the next ten to fifteen years, and therefore can be regarded as nearly constant. Similarly, the average dressing percentage, D, is unlikely to change markedly in the coming years.[1] It is also unlikely that L_M, the percentage carcass shrinkage during meat shipments, will fall relative to L_L, the percentage carcass shrinkage during shipments of live animals.[2]

Before considering the four crucial policy variables, P_{MA}, P_{FN}, $\bar{C}_M$, and $\bar{C}_L$, it is first necessary to explain why X, the offal/meat price ratio in

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[1] Furthermore, relationship (5) is not very sensitive to changes in D as D takes values from .4 to .6 (the maximum likely range of variation in D).

[2] There is much more room for reducing carcass shrinkage during cattle shipments than during meat shipments, particularly for cattle shipped by rail. Speeding up transit time (e.g., by reducing the amount of time spent on sidings) could lead to a reduction in weight losses of cattle and would increase the profitability of shipping live animals as opposed to meat. Therefore, in the following analysis, the possibility of lowering shrinkage during meat shipment relative to shrinkage during live animal shipments is ignored.

Abidjan, is likely to remain fairly stable in the near future. The price ratio is a function of consumer preferences and incomes in Abidjan (i.e., the shape of the demand functions for offals and meat in Abidjan), and might be expected to change as incomes and the absolute price of meat change. Data presented elsewhere (27, Chapter 12) indicate a strong consumer preference for meat as opposed to offals; therefore, as real incomes rise, one might expect demand for meat to increase faster than the demand for offals, leading to a decline in X, the offal/meat price ratio. Whether X decreases as incomes rise, however, depends on several factors, including whether consumers of protein other than meat and offals (e.g., fish) begin consuming offals as their incomes rise.[1]

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[1] It can be shown that X will decline as incomes rise when

$$P_{FA} > \frac{F_{FA}}{F_{MA}} \cdot \frac{\eta_{YFA}}{\eta_{YMA}} \cdot P_{MA} \qquad (6)$$

where

P_A = original price of offals in Abidjan;

F_{FA} = price flexibility of demand for offals in Abidjan (approximately equal to the inverse of the price elasticity of demand for offals);

F_{MA} = price flexibility of demand for meat in Abidjan;

η_{YFA} = income elasticity of demand for offals in Abidjan;

η_{YMA} = income elasticity of demand for meat in Abidjan; and

P_{MA} = original price of meat in Abidjan.

If, as seems reasonable, $\eta_{YMA} > \eta_{YFA}$, and $|F_{FA}| > |F_{MA}|$, then whether inequality (6) holds depends on the absolute magnitude of these parameters and on the size of P_{MA} and P_{FA}. If, however, as incomes rose, there were a large shift in consumption from fish to offals (i.e., if η_{YFA} were greater than η_{YMA}), then inequality (6) would be unlikely to hold. The experience of developed countries, however, suggest that in the long run, as incomes rise, the offal/meat price ratio falls.

How the offal/meat price ratio, X, will behave as the absolute price of meat in Abidjan increases depends on the size of the own-price elasticity of demand for offals and the cross-price elasticity of offals with respect to meat. If the cross-elasticity is equal to the own-price elasticity, then X will remain unchanged as the price of meat increases. If the cross-elasticity is greater than the own-price elasticity, then X will increase as the price of meat increases.[1] It is likely that in Abidjan the cross-

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[1] Let P_{MA} = original price of meat in Abidjan;

P_{FA} = original price of offals in Abidjan;

$X = P_{FA}/P_{MA}$

X is unchanged when P_{MA} increases when:

$$\frac{dX}{dP_{MA}} = 0 = \frac{P_{MA}\frac{dP_{FA}}{dP_{MA}} - P_{FA}}{(P_{MA})^2} = \frac{1}{P_{MA}}\left[\frac{dP_{FA}}{dP_{MA}} - \frac{P_{FA}}{P_{MA}}\right] = 0$$

Solving for $\frac{dP_{FA}}{dP_{MA}}$ yields $\frac{dP_{FA}}{dP_{MA}} = \frac{P_{FA}}{P_{MA}}$. Using the chain rule,

$$\frac{dP_{FA}}{dP_{MA}} = \frac{dP_{FA}}{dP_{FA}}\ \frac{dQ_{FA}}{dP_{MA}} = \frac{P_{FA}}{P_{MA}}, \quad \text{or} \quad \frac{dQ_{FA}}{dP_{MA}} \cdot \frac{P_{MA}}{P_{FA}} = \frac{1}{\frac{dP_{FA}}{dQ_{FA}}}$$

$$\therefore \quad \frac{dQ_{FA}}{dP_{MA}} \cdot \frac{P_{MA}}{P_{FA}} \cdot \frac{P_{FA}}{Q_{FA}} = \frac{1}{\frac{dP_{FA}}{dQ_{FA}}} \cdot \frac{P_{FA}}{Q_{Fa}}$$

$$\eta_{FMA} \approx \eta_{PFA}$$

where

Q_{FA} = quantity of offals demanded in Abidjan;

η_{FMA} = cross-elasticity of demand for offals with respect to meat in Abidjan; and

η_{PFA} = price elasticity of demand for offals in Abidjan.

If $\eta_{FMA} > \eta_{PFA}$, then $\frac{dX}{dP_{MA}} > 0$, i.e., the offal/meat price ratio increases as the price of meat increases.

elasticity of offals with respect to meat is fairly high because meat purchases represent an important part of consumers' food budgets and as the price of meat increases, consumers shift from buying more preferred to less preferred types of animal protein. For a large part of the Abidjan population, such a shift corresponds to buying more offals and less skeletal meat. If this shift were large enough (i.e., if the cross-elasticity were high enough) the offal/meat price ratio could even increase as the price of meat increases.

The preceding discussion suggests that in the near future, decreases in the offal/meat price ratio due to income effects may be offset by increases in the ratio due to price effects. In the following analysis, X (the price ratio) is taken as a constant, although later it is allowed to vary.

If shrinkage during transit, dressing percentages, and the offal/meat price ratio in Abidjan remain unchanged, the future profitability of the meat trade compared with the live animal trade will depend only on changes in the wholesale price of meat in Abidjan (P_{MA}), the wholesale price of the fifth quarter in the producing regions (P_{FN}), and the relative transfer costs ($\bar{C}_M$ and $\bar{C}_L$). Relationship 5 states that given transfer costs, if the price of offals in the exporting region exceeds a certain percentage of the price of meat in Abidjan, it becomes profitable to export meat. If the price of the fifth quarter in the north is fairly high relative to the Abidjan price, the merchant loses comparatively little by selling the fifth quarter in the north rather than shipping it on to Abidjan (in the form of a live animal) where its price is higher. He more than makes up this loss by the meat he "saves" due to the lower carcass shrinkage in meat shipments. Relationship 5 further states that if meat prices in Abidjan increase relative to fifth quarter prices in the producing areas and the offal/meat price ratio in Abidjan remains unchanged, it becomes less, not more, profitable to ship meat south. As the meat price in Abidjan rises, so does the price of the fifth quarter in Abidjan, and it becomes increasingly profitable to send both the meat and the fifth quarter south in the form of live animals. Relationship 5 implies that unless means are found to increase the demand for fifth quarter products in the producing areas (e.g., through processing and export of offals) expansion of meat exports from these areas may be self-braking. Expanding slaughter in order to export meat from the producing zones will lead to increased supplies of offals in these areas. Without an increase in demand for fifth quarter in the producing areas, the price of the fifth quarter there will fall relative to Abidjan, and the profitability of live animal shipments relative to meat shipments will increase.[1]

The absolute profitability of meat shipments depends on the price of meat in Abidjan compared to the price of meat in the north. The relative profitability of meat verses live animal shipments, however, depends not only on relative prices in the north and the south, but also on the ratio of the price of offals in Abidjan to the price of meat in Abidjan. This is shown in Figure 1, which shows how the margins earned shipping meat and live animals to Abidjan, M_M and M_L, vary as X, the Abidjan offal/meat price ratio varies. Figure 1 is drawn using the values for D, L_L, L_M, and y corresponding to cattle and beef shipped from Ouagadougou to Abidjan by rail in early 1977 (namely D = .49, $L_L = .09$, $L_M = .04$, = .55, and y = .175), and assuming two different meat prices in Abidjan.[2] In both cases, when (the Abidjan offal/meat price ratio), exceeds about .4, it becomes more profitable to ship live cattle than to ship meat. In early 1977, X was about .55; therefore, little chilled meat was shipped to Abidjan from the north. Given the prices in early 1977, it was only profitable to ship high quality meat from the north to Abidjan. High income consumers in Abidjan paid a premium for this meat, therefore the offal/meat price ratio for this meat

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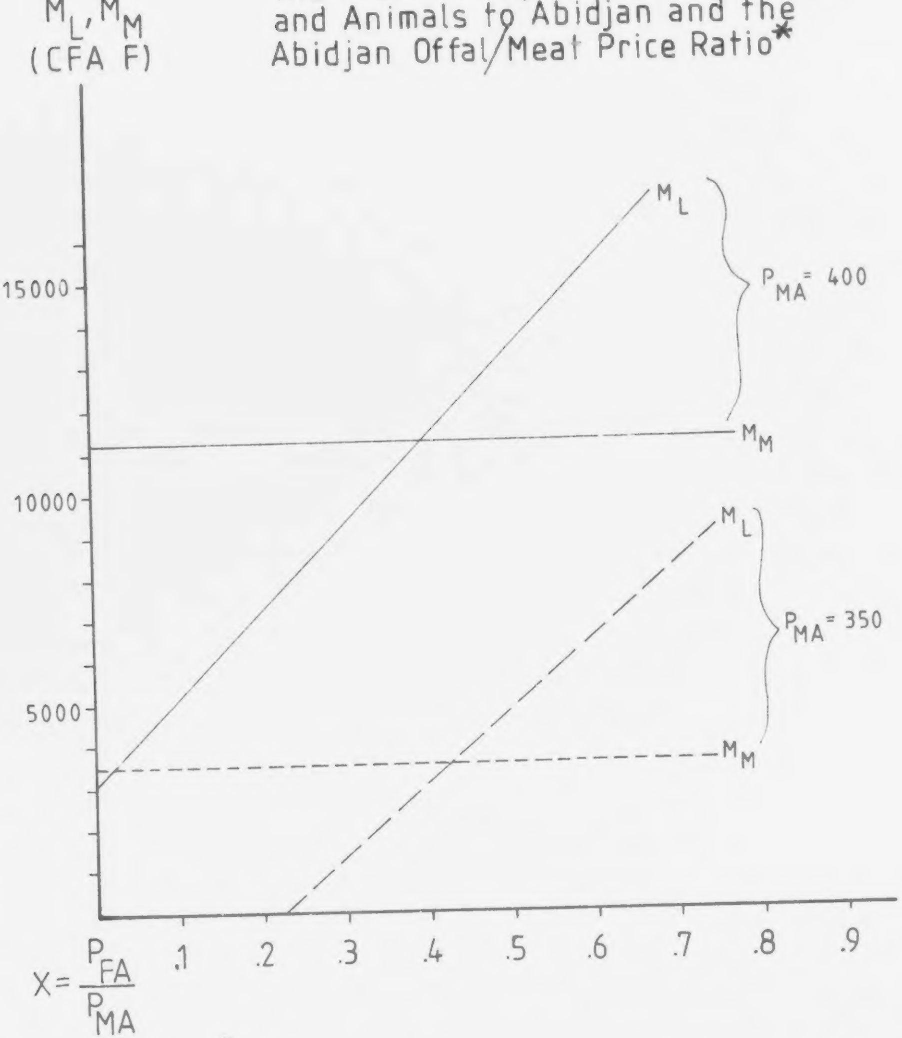
[1] Expanded meat shipments to Abidjan would also increase the supply of meat relative to the supply of offals in Abidjan, leading to an increase in the offal/meat price ratio in Abidjan. This would further increase the relative profitability of shipping live animals rather than meat.

[2] See 27, p. 267 for details of how these values for D, L_L, L_M, X and y were calculated. A constant cattle price of 250 CFA F per kg carcass weight is assumed for Ouagadougou, so the two different prices shown in Abidjan represent two different relative north-south prices.

FIGURE 1: Relationship Between the Profitability of Exporting Meat and Animals to Abidjan and the Abidjan Offal/Meat Price Ratio*



* $X = \frac{P_{FA}}{P_{MA}}$ where P_{MA} = wholesale price of beef in Abidjan

P_{FA} = wholesale price of the fifth quarter (offals) in Abidjan

M_M = margin earned exporting meat to Abidjan

M_L = margin earned exporting live animals to Abidjan

The figure is drawn using the parameters described in the text and assuming a cattle price in the north of 250 CFA F per kg. carcass weight.

was low.[1] For ordinary quality meat no premium was paid, and the only way in which shipments of ordinary quality meat could have become more profitable than shipments of live animals given the prevailing prices would have been for changes to occur in the relative transfer costs (C_M and C_L) or in the shrinkage rates for meat and live animals (L_M and L_L).

Three policy implications follow from this discussion. First, given current prices, exporting meat from the north will remain less profitable than exporting live animals unless processing and transportation costs for meat and shrinkage of meat en route (C_M and L_M) fall relative to transportation costs and shrinkage for live animals (C_L and L_L). Second, an increase in the price of meat in Abidjan alone will not make it more profitable to ship meat than to ship live animals. In fact, if the price of meat and fifth quarter in Abidjan rises relative to the price of the fifth quarter in the north, the profitability of shipping chilled meat will decline relative to that of shipping live animals. Third, the value of the fifth quarter plays a crucial role in determining whether it is more profitable to ship live animals or meat. For meat exports to become and remain more profitable than shipments of live animals, not only must transportation costs for meat decline relative to those for animals, but means must also be found to increase the demand for the fifth quarter in the north. Processing and export of offals may be one way of doing this.

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[1] Stated another way, it was profitable to ship high quality meat because the value of the meat "saved" because of reduced shrinkage in carcass shipments was very high, and more than offset the loss incurred in selling the fifth quarter in the north were its price was lower than in Abidjan.

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